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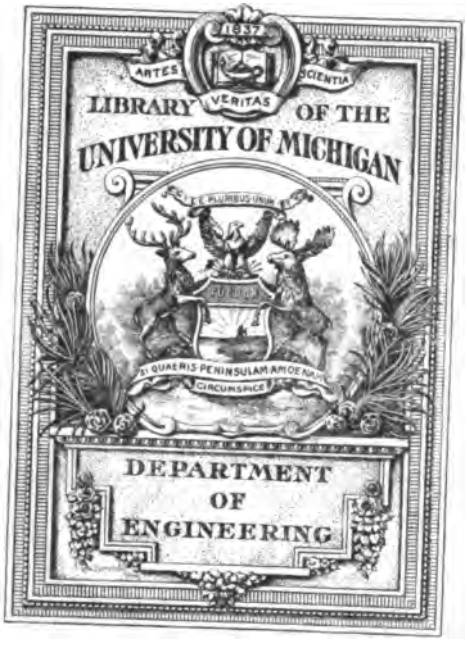

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59TH CONGRESS, 1st Session. | HOUSE OF REPRESENTATIVES. | DOCUMENT No. 2.

ANNUAL REPORTS

OF THE

WAR DEPARTMENT

FOR THE

FISCAL YEAR ENDED JUNE 30, 1905.

VOLUME VIII.

SUPPLEMENT TO THE REPORT OF THE CHIEF OF ENGINEERS.

REPORT OF THE MISSISSIPPI RIVER COMMISSION.

4

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

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ARRANGEMENT OF THE ANNUAL REPORTS OF THE WAR DEPARTMENT FOR THE YEAR ENDED JUNE 30, 1905.

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Inspector-General.
Judge-Advocate-General.

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Commissary-General.
Surgeon-General.
Paymaster-General.
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Chief of Ordnance.[b]
Chief Signal Officer.
Chief of Artillery.
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Volume III.....**Division and Department Commanders:**
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Volumes V–VIII....Chief of Engineers.

Volume IX.....Chief of Ordnance.

Volumes X–XIV....The Chief of the Bureau of Insular Affairs, the Philippine Commission, and Acts of the Philippine Commission.

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[a] Printed in Report of Chief of Engineers, Vol. V.
[b] Printed in Report of Chief of Ordnance, Vol. IX.

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ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1905.

OFFICE MISSISSIPPI RIVER COMMISSION,
St. Louis, Mo., June 30, 1905.

SIR: The Mississippi River Commission has the honor to submit this its annual report for the year ending June 30, 1905.

The act of June 28, 1879, by which the Commission was created, defined its duties as follows:

> To direct and complete such surveys of said river, between the Head of the Passes near its mouth to its headwaters, as may be in progress, and to make such additional surveys, examinations, and investigations, topographical, hydrographical, and hydrometrical, of said river and its tributaries as may be deemed necessary by said Commission to carry out the objects of this act. * * * To take into consideration and mature such plan or plans and estimates as will correct, permanently locate, and deepen the channel and protect the banks of the Mississippi River; improve and give safety and ease to the navigation thereof; prevent destructive floods; promote and facilitate commerce, trade, and the postal service; * * *

Under the authority of this act and subsequent laws relating to the subject, surveys and observations have been carried on, and works of improvement under the authority and direction of laws making appropriations for that purpose have been undertaken and executed. The original project contemplated the permanent location and deepening of the channel by engineering works for the contraction of the low water width where necessary, the protection of the banks against caving, and the confinement of the discharge at flood stages by levees. These works were prosecuted with effect for a number of years in two selected parts of the river known as Plum Point reach and Lake Providence reach, and with highly beneficial results in the improvement of the channel in those reaches. But the work done in them, while demonstrating the soundness of the theory upon which it was based, also demonstrated that the general improvement of the channel by contraction and revetment works would necessarily consume too long time and involve too great expense to meet the needs of commerce. It happened, also, fortunately, that as that fact became apparent the progress of engineering skill and invention had reached the point at which dredging machines became possible of such power and efficiency as to hold out the hope that an immediate and economical solution of the problem of deepening the channel for navigation might be found in the opening and maintenance of channels across the obstructing bars at low water by means of dredging. After studies and experiments extending over several years this method of improvement of the low-water channel was adopted and has been applied with success. The history of the work from the beginning, and of the experiences which led to this change of plan, and the reasons for such change, are fully detailed in former reports.

The general repair and construction of levees was first authorized without qualifying restrictions by the act of September 19, 1890, and since that date this work has formed one of the most important

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items in the operations of the Commission, about one-half of the appropriations made by Congress being devoted to that purpose.

The general project under which the work of the Commission has been conducted for several years past, and which is proposed for the year to come, may be stated as follows:

1. Continuation of surveys; preparation and publication of maps; maintenance of gauges; the recording, tabulation, and publication of gauge readings, and the taking and recording of discharge measurements and other observations.
2. The building, extension, and repair of levees.
3. The building, maintenance, and operation of dredge boats.
4. The repair of existing works for the improvement of the channel, the preservation of harbors, the prevention of cut-offs, and the security of levees.

Other miscellaneous details incident to the execution of the general project.

All of which will be specified in detail in what follows.

APPROPRIATIONS AND ALLOTMENTS.

By the sundry civil act approved April 28, 1904, the sum of $2,000,000 was appropriated for continuing improvement of Mississippi River from Head of Passes to the mouth of the Ohio River, including salaries and clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission. The amount thus appropriated was allotted, on the recommendation of the Commission, as follows:

Mississippi River Commission	$30,000	
Surveys, gauges, and observations	50,000	
Dredges and dredging	307,000	
		$387,000
FIRST AND SECOND DISTRICTS.		
Surveys	5,000	
Repairs to revetments at Fletchers Bend and Osceola bar, including quarrying of stone	100,000	
Hopefield Bend	120,000	
New Madrid	10,000	
Helena	10,000	
Plant	50,000	
Levees	310,000	
		605,000
THIRD DISTRICT.		
Surveys	5,000	
Repairs to revetment at Lake Providence and general repairs, including quarrying of stone	67,000	
Plant	20,000	
Longwood revetment	100,000	
Levees	380,000	
		572,000
FOURTH DISTRICT.		
Surveys	5,000	
Repairs of revetment at Bondurant	3,000	
Repairs of revetment at Kempe Bend	80,000	
Plant	38,000	
Levees	310,000	
		436,000
		2,000,000

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By the act approved April 28, 1904, authority was given to the Secretary of War, as recommended by the Mississippi River Commission, to enter into contract or contracts for levee work upon the Mississippi River between Cairo and the Head of Passes during the fiscal year ending June 30, 1905, to the extent of $1,000,000, to be paid for out of the appropriation for that stretch of the river authorized by the river and harbor act of 1902 for the fiscal year ending June 30, 1906, when the appropriation for the last-named fiscal year shall become available.

Pursuant to this act allotments were made upon the recommendation of the Commission of sums for which contracts for levee work in the several districts may be made as follows, to be paid for out of the appropriation for the fiscal year ending June 30, 1906, when the appropriation for that year shall become available:

Upper St. Francis levee district	$15,000
Reelfoot levee district	15,000
Lower St. Francis levee district	140,000
Upper Yazoo levee district	70,000
White River levee district	70,000
Lower Yazoo levee district	150,000
Upper Tensas levee district	230,000
Lower Tensas levee district	110,000
Atchafalaya levee district	40,000
Lafourche levee district	40,000
Pontchartrain levee district	90,000
Barataria levee district	15,000
Lake Borgne levee district	15,000
	1,000,000

By the sundry civil act, approved March 3, 1905, the sum of $2,000,000 was appropriated for continuing improvement in completion of contract authorization of Mississippi River from Head of Passes to the mouth of the Ohio River, including salaries and clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission. The amount thus appropriated was allotted, on the recommendation of the Commission, as follows:

SECRETARY.

Mississippi River Commission	$26,000	
Surveys, gauges, and observations	65,000	
Dredges and dredging	395,000	
		$486,000

FIRST AND SECOND DISTRICTS.

Plum Point reach	65,000	
Hopefield Bend	40,000	
Care, repair, and renewal of plant	50,000	
Levees	310,000	
Surveys	5,000	
Harbor of Memphis (Wolf River)	8,000	
		478,000

THIRD DISTRICT.

Repairs and extension of revetment work, including quarrying of stone	100,000	
Care, repair, and renewal of plant	40,000	
Levees	380,000	
Surveys	5,000	
		525,000

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FOURTH DISTRICT.

Repairs to revetment at Bondurant	$2,000	
Rectification of Atchafalaya and Red rivers, Louisiana	24,000	
Care, repair, and renewal of plant	45,000	
Levees	310,000	
Surveys	5,000	
Harbors of Natchez and Vidalia, Mississippi and Louisiana	40,000	
Harbor of New Orleans, Louisiana	85,000	
		$511,000
		2,000,000

The following allotments and reallotments have also been made:

ALLOTMENTS.

From reserve in hands of President to fourth district officer for dredging in Lower Old River (from appropriation of June 13, 1902)	$1,000

REALLOTMENTS.

From Lower Yazoo levee district, 1905, to Longwood revetment (appropriation of April 28, 1904)	50,000
From Ashbrook Neck, 1904, $14,000; general repairs to existing works, 1904, $9,000; stone, third district, 1904, $13,000; to plant, first and second and third districts (appropriation of March 3, 1903)	36,000
From Upper Yazoo levee district, 1906, to Upper St. Francis levee district (appropriation of March 3, 1905)	10,000

Details of the expenditure of the foregoing allotments are appended hereto.

By the river and harbor act approved March 3, 1905, the sum of $1,000,000 was appropriated for improving the Mississippi River from the Head of the Passes to the mouth of the Ohio River, including salaries, clerical, official, traveling, and miscellaneous expenses of the Mississippi River Commission. The amount thus appropriated was allotted, on the recommendation of the Commission, as follows:

FIRST AND SECOND DISTRICTS.

Levees:		
Upper St. Francis levee district	$30,000	
Lower St. Francis levee district	140,000	
White River levee district	200,000	
		$370,000

THIRD DISTRICT.

Levees:		
Lower Yazoo levee district	125,000	
Upper Tensas levee district	110,000	
Revetments:		
Bolivar	50,000	
Longwood	35,000	
		320,000

FOURTH DISTRICT.

Levees:		
Lower Tensas levee district	85,000	
Atchafalaya levee district	30,000	
Lafourche levee district	15,000	
Barataria levee district	15,000	
Pontchartrain levee district	60,000	
Lake Borgne levee district	15,000	
Revetment:		
Kempe Bend	90,000	
		310,000
		1,000,000

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By the river and harbor act approved March 3, 1905, authority was given to the Secretary of War to enter into a contract or contracts for such materials and work as may be necessary to carry on continuously the plans of the Mississippi River Commission, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate $2,000,000.

Pursuant to this act the Commission has recommended that levee work in the Reelfoot district be placed under contract to the amount of $100,000, to be paid for from the appropriation for the fiscal year ending June 30, 1907. This recommendation was approved with the proviso that work should not begin prior to July 1, 1906.

During the year the membership of the Commission was changed by the appointment of Lieut. Col. Clinton B. Sears, Corps of Engineers, U. S. Army, to membership, vice Lieut. Col. Henry M. Adams, Corps of Engineers, U. S. Army, relieved.

The following changes in the personnel of officers in charge of works under the Commission have occurred during the year:

Capt. George M. Hoffman, Corps of Engineers, U. S. Army, relieved Capt. E. W. Van C. Lucas, Corps of Engineers, U. S. Army, of his duties in charge of the third district on February 1, 1905.

Capt. James F. McIndoe, Corps of Engineers, U. S. Army, relieved Capt. Charles S. Bromwell, Corps of Engineers, U. S. Army, of his duties in charge of the fourth district on July 7, 1904.

Three meetings of the Commission have been held during the year—the ninety-third, which was held on board the steamer *Mississippi* during the annual low-water inspection of the river from November 10 to November 19, 1904, inclusive; the ninety-fourth, which was held on board the steamer *Mississippi* during the annual high-water inspection of the river from April 5 to April 13, 1905, inclusive; and the ninety-fifth, which was held at the office of the Commission at St. Louis on June 19, 1905.

SURVEYS AND MAPS.

The field work of the surveys comprises secondary triangulation, precise levels, topography, and hydrography. The secondary triangulation now covers the entire river from the Head of Passes to the headwaters of Lake Itasca, a distance by river of about 2,347 miles. The triangulation follows the river to Aitkin, Minn., about 1,086 miles above Cairo. From Brainerd, Minn., about 55 miles below Aitkin, it is carried directly across country to Lake Itasca, and thence down the river to Lake Bemidji. From Lake Bemidji a base line, whose length and azimuth are accurately determined, has been carried along the railroad to Grand Rapids, thence down the State road to Aitkin, thus forming a loop. This base line forms the basis of the topographic and hydrographic work along the river. The precise levels also cover the entire river and generally follow the same lines as the triangulation, but extend down to the end of the jetties at the mouth of South Pass. The topography and hydrography of the river are also completed from the Head of Passes to its headwaters, including the Itasca State Park. The reduction and platting of the field notes of the work of the past two seasons is in progress.

The low-water survey between Cairo and the mouth of the Arkansas River, begun in 1902 and suspended during 1903 because of high

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water, was resumed September 1, 1904. The field work was completed to the mouth of the Arkansas River November 7, 1904. The notes of this survey are now being reduced and platted, preparatory to a comparison between them and those of the first general survey of this part of the river in 1880 to 1882.

An accurate survey of the Atchafalaya River from Barbre Landing to the junction of the Little Atchafalaya and upper Grand rivers was begun December 9, 1904, and completed February 1, 1905. The distance covered was 69 miles.

The reduction of field notes and the platting, drawing, and publication of maps have been continued. Detail charts Nos. 219 to 225, inclusive, were published to a scale of 1 to 10,000. This extends the series from Minneapolis, Minn., to about 1½ miles below Brainerd, Minn., 1,039 miles above Cairo. Map No. 136, inch to the mile series, was published. This extends the series to the upper limits of the city of Minneapolis, Minn.

During the year the results of surveys of the Mississippi River between Fort St. Philip and the Head of Passes, made by the Commission and others from 1838 to 1904, were reduced, platted, and compared in width, maximum depths, and areas by Assistant Engineer A. T. Morrow. The results of the last survey indicate that a general decrease in depth has taken place, without change in width. But the conditions of stage preceding the several surveys complicate the problem to such an extent that further examinations should be made in future years before definite conclusions can be drawn. The detailed comparisons are given in Assistant Engineer Morrow's report, hereto appended, marked "Appendix B."

GAUGES.

Permanent gauges.—There are 38 permanent gauges, comprising 17 established by the Commission and 21 received by transfer from the United States engineer office at Vicksburg in 1901. They are distributed as follows: 25 on the Mississippi River from St. Louis, Mo., to Fort Jackson, La.; 1 on the Atchafalaya River; 1 each on the Arkansas, Cumberland, Tennessee, and St. Francis rivers; 3 on the Red River; 3 (including Cairo) on the Ohio River; 2 on the White River. The gauges established by the Mississippi River Commission are maintained by allotments from the appropriation for Improving Mississippi River from Head of Passes to the mouth of the Ohio River, and the others by allotment from the permanent appropriation for gauging the waters of the Mississippi River and its principal tributaries, established by acts of August 11, 1888, and June 13, 1902. A description of these gauges is printed in the supplement to the Report of the Chief of Engineers for 1902, pages 52 to 59. The permanent gauges have been inspected and maintained during the year, gauges and bulletins being repaired when necessary.

The highest and lowest readings on the permanent gauges during 1904, with the previous highest and lowest for comparison, the highest and lowest readings for each year since 1898, and a hydrograph showing the daily stages of the main river from Cairo to Fort Jackson from June 1, 1904, to May 31, 1905, are given in the report of the secretary, appended hereto.

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High-water gauges.—The high-water gauges are 185 in number, distributed on the Mississippi River from Cairo to the Head of Passes, about 5 miles apart. These gauges are read at times of highest water only, and supplement the permanent gauges in determining the high-water slope of the river. They were not read this year, as flood stages were not reached.

Tide gauges.—The tide gauges at Biloxi, Miss., and East Bay, Louisiana, have been maintained in good order and continuous records for the year secured.

DISCHARGE OBSERVATIONS.

The high-water discharge of the Arkansas River was measured at Little Rock, Ark., in June and again in July, 1904. The low-water discharge of the Mississippi at Carrollton, La., and of the Atchafalaya at Neita, La., were measured in December, 1904. The discharge of the Red River at Alexandria, La., was measured during the high water of May and June, 1905. All these discharges were made at practically the extreme stages reached. The results are given in the report of the secretary and its appendixes.

DREDGES AND DREDGING.

The low-water conditions of 1891 emphasized the necessity of temporary expedients for the improvement of navigation. During that year the grain crop was large and the European demand for it was great, but unfortunately the condition of the channel was such that navigation was practically suspended, while millions of bushels of grain accumulated in the elevators. As a consequence, urgent demands were made upon the Commission for relief by the temporary removal of the crests of obstructing bars. The subject was thoroughly canvassed by the Commission, which came to the conclusion that "some dredge of great capacity, which can remove the material bodily and can itself be readily moved from place to place, is essential in order to give a reasonable chance for success."

In accordance with this conclusion an experimental dredge was built, and the success achieved therewith was such that other dredges followed, and in 1896 a definite project was adopted for maintaining, by means of dredges, at all stages, a channel at least 9 feet in depth and 250 feet wide.

In the development of a dredging plant that would meet such extraordinary requirements a new field was entered upon, where valuable precedents as guides were meager. The defects that were developed in the actual work of a dredge were carefully eliminated from each of the successive dredges as they were built, the new dredge showing material improvement on its predecessor. The elaborate series of dredge tests that were made settled other doubtful points as to the relative merits of the several elements which go to make up a complete and satisfactory working dredge. The results of a working experience of more than ten years, supplemented by the dredge tests, are embodied in plans and specifications that have been drawn for the tenth dredge, which is now under construction.

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The work of dredging begins at a bar when the depth of water over the crest is still several feet in excess of the least requirement of navigation. Hence the bar is never permitted to reach a condition where it would prove an obstruction, as the work of deepening proceeds much faster than the decline in stage.

The results obtained by dredging during several successive seasons have been such as to fully establish the fact that it is entirely practicable to maintain an ample navigable channel at all stages by means of a suitable equipment of dredges. It is evident, however, that the confidence of the capitalist who must provide the means for building river craft and the steamboat man who navigates it can only be secured by the complete and uninterrupted maintenance of an adequate channel for a period of several years, and the assurance that an ample plant will at all times be maintained and operated by the Government to meet all the difficulties that may arise.

The success achieved in the past and the consequent faith the Commission has in the efficacy of dredges in the maintenance of a satisfactory navigable channel justifies the recommendation here that ample funds be provided by law for carrying on continuously the work of dredging—that is to say, the continued maintenance of the channel is too important a matter to be subjected to interruption through possible failure of appropriation bills. One failure of that kind would destroy the confidence established by many years of successful maintenance of channel.

A statement of the project under which the hydraulic dredges of the Commission have been built, maintained, and operated, with the dates of completion of the several dredges, will be found on page 8 of the Annual Report for 1904.

During the low-water season of 1904 six dredges, the *Delta*, the *Epsilon*, the *Zeta*, the *Iota*, the *Kappa*, and the *Henry Flad*, were in the field. The *Beta* was in commission for about two weeks, but did not leave the fleet, while the *Gamma* was caught by low water in the Ohio River and detained for the entire season at Louisville, Ky., where she had been sent to be docked. The dredges were assigned to different portions of the river, and the customary surveys were made for the purpose of placing the dredges intelligently and of determining the results of their operations. The dredging season covered the period from about August 22 until December 31, with some intervals when work was suspended by small rises in the river. During this period dredging was required at seventeen localities between Nolans (76) and Andersons (359). Low stages were reached early in the season, and lasted until quite late, and the number of hours spent in actual dredging was 30 per cent greater than in any previous year. Notwithstanding the large amount of work required, depths of 9 feet and over were maintained on all bars except at Presidents Island, where at four different times depths of 8½ and 8 feet were recorded. The material met with at this point was a very hard, compact gravel in which dredging was difficult and progress slow.

SURVEY FOR 14-FOOT WATERWAY, MISSISSIPPI RIVER, FROM THE MOUTH OF THE ILLINOIS RIVER TO ST. LOUIS, MO.

A full history of this survey up to the date of the last annual report is published in the supplements to the reports of the Chief of Engineers for 1903, pages 7 and 68, and 1904, page 11. During the season of

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1904 the platting of previous work was completed, additional data secured and put on the maps, borings made, and plans, detailed drawings, and estimates of cost prepared. The final report of the Commission upon this project has been prepared and forwarded to the Chief of Engineers. A copy is hereto attached.[a]

Details of the foregoing work may be found in the report of the Secretary and its appendixes, which accompany this report.

CHANNEL WORKS, BANK PROTECTION, AND HARBOR IMPROVEMENTS IN THE SEVERAL DISTRICTS.

First district, from Cairo, Ill., to the foot of Island 40 (220 miles).—Headquarters custom-house, Memphis, Tenn. District officer: Capt. E. W. Van C. Lucas.

Construction works for channel improvement, protection of caving banks and harbor work in this district are located at Columbus and Hickman, Ky., New Madrid and Caruthersville, Mo., and Plum Point reach, together with certain isolated works consisting of low-water channel dikes at different points throughout this district.

Columbus, Ky., 21 miles below Cairo, left bank.—The work at this point was done in 1889 and 1890, and consists of five submerged dikes, protecting about 2,200 feet of harbor front. No repairs have been made since, and while some minor work is desirable it is not at present absolutely necessary.

Hickman, Ky., 36 miles below Cairo, left bank.—The work at this point consists of 1,450 feet of effective continuous revetment placed in 1889, 1892, and 1894, to prevent caving along the lower portion of the town. Slight repairs were made in 1900 on account of injury to the revetment from local drainage. The work is now in good condition, and nothing additional is at present contemplated.

New Madria, Mo., 71 miles below Cairo, right bank.—This work consists of bank revetment, extending along the river front of the town, of continuous fascine mattresses 260 feet wide below low water, with riprap paving on the graded bank above low water. Nine hundred feet of revetment was constructed in 1893, and afterward extended as follows: 700 feet in 1894, 500 in 1896, 1,573 in 1898, and 1,000 in 1900. The present effective revetment is 4,450 feet long, and is in generally good condition excepting a few places near the low-water line, which will require minor repairs, whenever the river stage will permit. The channel crossing just above the town, mentioned in the last annual report, seems to be working downstream, and the extension of the revetment upstream may prove unnecessary.

Caruthersville, Mo., 110 miles below Cairo, right bank.—This work consists of spur dikes and continuous revetment for the protection of the caving bank in front of the town, the present effective length being 2,300 feet. This revetment is in good condition excepting at the lower end, where it is flanked by a deep cave, making a downstream extension advisable. There are indications of caving above the revetment, and an upstream extension may also be necessary. There is no urgent need at present for either extension.

Plum Point reach, 147 to 186 miles below Cairo.—The works in this reach comprise about 67,400 feet of revetment for the protection of

[a] Not printed.

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caving banks, the partial closure of the chutes behind Elmot bar and Island 30 with a brush and stone dam, the closure of Osceola and Bullerton chutes with pile dikes, and a levee along the left bank to confine the flood waters more closely to the river bed. The object of all these works was to increase the navigable depth at low water in a reach of river which had been noted for years for its obstructing sand bars. As a result the banks have remained practically fixed within the prescribed limits, and the navigable depth at low water has been increased to such an extent that little or no difficulty has been experienced in navigating this reach since the works approached completion.

At no time since the works were well under way has the navigable depth reached as low a point as it did nearly every low-water season prior to the construction of the rectification works.

During the past year work in this reach was principally on the Fletchers Bend revetment, and consisted of fascine revetment work to replace 2,328 feet of old woven mattress work destroyed during the last two or three years, and about 662 feet of reinforcing work of fascine mattress over the weakest part of the old woven revetment still in place. The Fletchers Bend revetment has now been completely restored, although about 2,300 feet of old work should be reinforced as soon as practicable. Some minor repairs were made to the Daniels Point and Bullerton revetments, but no work was necessary on the Ashport Bend and Osceola revetments.

Abattis dikes.—These dikes are used for the purpose of closing secondary chutes and contracting the low-water channels by building up the sand bars. No allotment was made for work of this class during the past season. Experience indicates that when properly placed these dikes are very effective in building up bars.

For further details concerning the first district see reports of Captain Lucas and Assistant Engineer Nolty, appended hereto.

Second district, foot of Island 40 to White River (173 miles).—Headquarters custom-house, Memphis, Tenn. District officer: Capt. E. W. Van C. Lucas.

This district includes the protection of caving banks and harbor work at Hopefield Bend, Memphis, Tenn., and at Helena, Ark., and also the dredging of Wolf River, Tenn.

Hopefield Bend, Ark., 227 to 230 miles below Cairo, right bank.—This revetment was originally 16,600 feet long, was constructed at various times between 1882 and 1889, and has been repaired from time to time since completion. At the beginning of the year the upper 6,300 feet previously destroyed had been partially replaced with 2,300 feet of new fascine mats, and during the year an additional 1,600 feet of new work was added, making the revetment again continuous. In addition, 2,100 feet of fascine mattress was placed as reinforcement over the lower part of the old-style work. This revetment has a present effective length of about 14,200 feet.

Wolf River, 230 miles below Cairo, left bank.—The part of this stream under improvement is a part of Memphis Harbor, and the improvement consists of dredging for the purpose of maintaining a navigable channel during the low-water season from its mouth 2½ miles upstream to the county bridge. During the past season 47,440 cubic yards of earth, 340 cubic yards of rock, and 166 snags and logs were removed, and the channel depth maintained, permitting navigation

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throughout the season. To maintain this channel depth dredging will be required during each low-water season.

Memphis Harbor, 230 to 232 miles below Cairo, left bank.—The work along the Memphis front embraces the protection of 14,800 linear feet of bank by means of spurs and continuous revetment, the upper portion of which is covered by a sand bar which encroaches somewhat upon the levee front of the city. The area of this bar between Wolf River and the levee front is about 100 acres at low water, of which 12 acres is above water at the 25-foot stage. It is believed that the progress of this bar downstream has been checked and that it is approaching a state of equilibrium which will be maintained as long as the present bank line in Hopefield Bend is held. The revetment along the Memphis front is in good condition. No repairs were made during the past season, and none are contemplated for the coming season. Its present effective length is 9,900 feet.

Helena, Ark., 306 miles below Cairo, right bank.—The revetment work at this place consists of the protection of 4,900 linear feet of river bank in front of the city, of which 3,500 feet is continuous revetment and 1,400 feet dike work. The caving or sloughing off at very low stages continued during the past season to a lesser extent than heretofore, but the levee is still dangerously threatened. To guard against this possible caving away, a cross levee has been built below the threatened part, connecting the main White River levee with the high ground to the west, and a similar cross line above the threatened part will be constructed by the local board for the protection of the city of Helena.

For further details concerning the work in the second district see reports of Captain Lucas and Assistant Engineer Rees herewith.

Third district, from White River to Warrenton, Miss. (214 miles).—Headquarters Vicksburg, Miss. District officers: Capt. E. W. Van C. Lucas, July 1, 1904, to February 1, 1905; and Capt. Geo. M. Hoffman, February 1 to June 30, 1905.

This district includes the works of improvement at Lake Bolivar Front, Ashbrook Neck, Greenville Harbor, and Longwood, Mississippi, and Louisiana Bend, Lake Providence revetment, and Delta Point, Louisiana. The operations of the past year included repairs to the revetments at Ashbrook Neck, Greenville Harbor, and Lake Providence revetment, and the construction of a revetment at Longwood, with an effective length of 4,200 feet.

Lake Bolivar front, 417 miles below Cairo, left bank.—The revetment at this point was built to hold a bank the caving of which threatened a levee extending across between the head of Lake Bolivar and the bank of the river, the destruction of which would have resulted in the abandonment of a large area of highly cultivated land. The original work constructed in 1888 and 1889 consisted of 4,200 linear feet of bank revetment, of which 3,775 feet is now effective. Slight repairs have been made at different times to the upper bank pavement, and the revetment is now in good condition for a length of about 3,650 feet. A recent change in the channel at this point has increased the attack of the current upon this work, and it is contemplated to reenforce it during the coming season with a standard fascine mattress having a length of about 2,000 feet.

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Ashbrook Neck, 446 miles below Cairo, left bank.—The object of the work at this point was to prevent a threatened cut-off which would have disturbed the regimen of the river for a long distance above and below and brought disaster to towns, levees, and other works along the river banks. Work was begun in 1890 and continued at intervals until 1895. Repairs have been made from time to time in the upper bank paving, and with reenforcing mats where the original revetment has shown signs of weakness. Minor repairs to the bank paving were made during the year, and the reenforcing of the remaining 2,000 feet of old woven mats is contemplated for next season, in addition to such minor repairs as may be necessary.

The present condition of the revetment is good.

Greenville Harbor, 478 miles below Cairo, left bank.—This work has for its object the rectification of the bank to prevent the encroachment of the river on the town of Greenville, and also to prevent the destruction of the controlling levee line which protects the Yazoo basin from overflow. During the twelve years from 1882 to 1894 the recession of the bank in the Greenville Bend amounted to 4,000 feet. This work was begun in 1887, when 10 submerged dikes were placed. The plan was changed to continuous revetment in 1891, and 14,500 feet of revetment have been placed, of which 12,100 feet is at present in effective condition. Since the completion of this work the bank line has been effectually maintained. The work of the past season consisted of the placing of three small pocket mats. During the bank-full stage of the river this spring a break in the bank paving, accompanied by a settlement of the inner edge of the mattress, occurred in the vicinity of the discharge of the sewage pumping plant. This break will be repaired during the coming season, and such minor repairs as may be needed will also be made.

Longwood, Miss., 500 miles below Cairo, left bank.—The object of this work was to hold the rapidly caving bank which threatened the large and costly levee at this point, the destruction of which would have necessitated the expenditure of more than $700,000 in the construction of a new line, besides throwing valuable land outside the levee system. The work was begun in the fall of 1904, and completed to an effective length of 4,200 feet during the season. The typical form of fascine mattress with upper bank paving was used. This work being undertaken solely for levee protection, part of its cost was met by the reallotment of $50,000 previously alloted to the levees of the district. The State levee board also contributed funds for use in the work. During the coming season the extension of the revetment about 1,000 feet downstream is contemplated.

Lake Providence reach, 517 to 552 miles below Cairo.—Prior to the improvement work this reach presented the most serious obstructions to low-water navigation of any portion of the river below Cairo, except perhaps the Plum Point reach. The depths were often as low as 4½ to 5 feet on the crossings. It was therefore selected by the Commission as one of the reaches where a project for systematic improvement should be carried out. The works in this reach resulted in a marked improvement in the channel depths, but they proved to be too light to long withstand the attacks of the floods. Revetment was for a time prohibited by Congressional enactment, appropriations failed, and the repairs and renewals deemed necessary to strengthen and hold the work

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already done could not be made, and in consequence of this the uncompleted works were badly wrecked. It may, however, be said that these works served a useful purpose by materially improving the navigation of the entire reach, which still continues better than it was before the work was begun. There has been but one low-water season since the works approached a stage of completion when the channel depth was not sufficient for the demands of navigation, and even during that season the depth was some 2 feet greater than the common low-water depths prior to the beginning of the improvement work.

Louisiana Bend, 522 miles below Cairo, right bank.—The revetment in this bend is part of the systematic improvement of Lake Providence reach. Work began in 1889 and was continued from time to time as funds were available until 1897. No extension or repair of this work has been made since then. The total length of the original work was 15,820 feet, of which about 4,000 at the lower end has been destroyed. About half the remaining work is protected by a large bar.

Lake Providence, 540 miles below Cairo, right bank,—The object of this revetment work was to control and hold the rapidly caving bank that threatened to destroy the town of Lake Providence and an important levee situated between the lake and the bank of the river, the destruction of which would have necessitated the building of a long line of new levee extending from Bunchs Bend around the lower end of Lake Providence and would have resulted in the abandonment of several square miles of cultivated land, including a portion of the town of Lake Providence. It was begun in 1894 and continued during the following year, further extensions being made in 1899 and 1900. The total length is now 12,600 feet, practically all of which is still effective. Minor breaks have developed from time to time, and the revetment has been extensively reenforced with modern fascine mats until only 2,200 feet of the original woven mat work remains unprotected.

The work of the past season included the repair of three small breaks and one considerable break in the upper bank paving. During the coming season it is contemplated to continue the work of reenforcing the old type woven mattress as far as the available funds will permit.

Delta Point, 598 miles below Cairo, right bank.—The object of this work has been to hold the point opposite Vicksburg and to prevent recession of the channel downstream away from the harbor, and so aid in the improvement of Vicksburg Harbor, now in charge of the Engineer Department. Caving above the work has continued and may require an upstream extension of the revetment in the near future. No work was done during the year and none is contemplated for the coming season. This work has now an effective length of 5,900 feet.

Further details of work in this district may be found in the reports of Captain Hoffman and Assistant Engineer Hider, hereto appended.

Fourth district, Warrenton, Miss., to Head of Passes, 607–1,060 miles below Cairo.—Headquarters, 3232 Prytania street, New Orleans, La. District officers: Lieut. Col. H. M. Adams, temporarily in charge, July 1 to 7, 1904, and after that date Capt. J. F. McIndoe.

The works include bank protection in Bondurant Chute, bank protection in Kempe Bend, improvement of the harbors at Natchez and Vidalia, rectification of the Red and Atchafalaya rivers, and improvement of the harbor at New Orleans, La.

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Bondurant Chute, 644 miles below Cairo, right bank.—This work was undertaken in order to prevent the destruction of the levee lying between the end of Lake Bruin and the bank of the river, no other location of the levee line being practicable in the immediate vicinity, and its abandonment involving the construction of a loop several miles long around and behind the lake. In addition to the cost of constructing this new line of levee to replace the old one, the abandonment of the latter would result in the exposure to overflow of a large amount of cultivated land.

This revetment consists of mattresses constructed of willow brush, and a few experimental ones built entirely of lumber for the submerged portion, with upper bank paving of concrete. During the past year the revetment has been repaired and extended 145 linear feet upstream, making a total length of 2,440 linear feet. It is now in good condition and is considered a complete work requiring only current repairs. It has resulted in the prevention of any further recession of the bank line, and consequent destruction of the levee.

Kempe Bend, 658 miles below Cairo, right bank.—The object of this work has been to prevent further erosion of the bank line in Kempe Bend, which has already destroyed several lines of levee and nearly reached a final line, the destruction of which would necessitate a long line of new levee of extremely difficult and costly construction. The construction of a new line would also require a long period of time, and a break in the front line in the meantime would be disastrous to a large section of the country below Kempe. Work on this revetment was begun in 1899 and continued each season since that time until, at the date of the last annual report of the Commission, it had reached a length of 7,593 feet of revetment, in three detached places, 5,315, 1,395, and 883 feet, respectively.

During the past season the gaps between the detached pieces have been closed by the placing of 2,885 linear feet of mattress work, making the subaqueous portion of the revetment continuous for a length of 10,311 linear feet. In addition to this, 2,700 linear feet of upper bank was graded and 865 linear feet paved. Extensive repairs were also made to the existing work. This work has been successful thus far in protecting the levee, though numerous small failures of portions of the revetment have occurred, permitting the upper bank line to recede slightly. The present condition of the work is good.

Harbors at Natchez and Vidalia, Miss. and La., 688 miles below Cairo, left bank.—The object of this work is to prevent a threatened cut-off which would destroy the harbors of Natchez and Vidalia and disturb the general regimen of the river for many miles above and below. The general project for the work contemplates the construction of a levee on or near the axis of Cowpen Neck, to prevent a flow of water across the neck during high stages of the river, and the construction of about 16,000 linear feet of revetment in Giles Bend. The revetment now covers a length of 15,908 feet, in three detached stretches of 8,192, 693, and 7,023 feet, respectively, having been extended 1,337 feet during the year. Extensive repairs to the existing work have also been made. All the work that has been placed has been effective in maintaining the bank line, but further extension of the revetment will be required. The levee built along the axis of Cowpen Neck in conjunction with this work is in fair condition, requiring

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only minor repairs. Since the flood of 1903 caving along the harbor front of the city of Natchez has become very active. Operations at this point have generally been carried on under special appropriations, and the recommendation for the continuance of these appropriations, as made in the last annual report, is renewed.

Junction of the Mississippi, Red, and Atchafalaya rivers, La., 764 miles below Cairo.—The improvement in this locality consists in the maintenance of mattress sill dams in the Atchafalaya River for the purpose of preventing the enlargement of that stream, and dredging the low-water channel of Old River for the purpose of maintaining an adequate depth between the Mississippi, Red, and Atchafalaya rivers.

The original sills were placed in 1887–88, and since that time no enlargement of the Atchafalaya has been observed. The dams are apparently in good condition, and beyond slight repairs to maintain them no further work is contemplated in this section.

During the past season some dredging was required in lower Old River in order to maintain a suitable channel for navigation, and annual dredging is likely to be required, the principal obstruction being now the bar at the mouth of Old River. The physical changes in this vicinity are carefully measured by means of frequent surveys, as it is important to ascertain promptly any tendency to enlargement in the bed of Old River or at the head of the Atchafalaya. The survey of this year shows but little change from those of previous years. The importance of maintaining the present conditions requires that sufficient funds should be reserved to check immediately any tendency toward enlargement and keep Old River and the Atchafalaya at all times under safe control.

New Orleans Harbor, 965 miles below Cairo, right and left banks.—The object of the work in this harbor is to prevent the erosion of banks and consequent loss and damage to adjacent property. The work consists mainly of spur dikes placed at intervals of about 450 feet, and of continuous revetment of the lower bank. In places where erosion was specially active continuous revetment was placed between the spurs. The banks are now protected in Carrollton Bend for 7,360 feet by continuous mattress, and for 1,970 feet by five spur dikes in conjunction with continuous mattress; in Greenville Bend, opposite Audubon Park, for 1,940 feet by two spur dikes; in the Gouldsboro-Algiers Bend, for 9,135 feet by eighteen spur dikes; and in the third district reach, for 6,535 feet, by fourteen spur dikes, and for 1,240 feet by two spur dikes and a continuous mattress. A total of about 5½ miles of bank is thus protected by dikes and continuous revetment. During the past season no construction work was done because of lack of funds. The steep banks and great depths of water make the preservation of the banks in New Orleans Harbor both difficult and expensive, and the danger of sudden collapse in certain localities is by no means remote. Under the conditions here found it is of more than ordinary importance that ample means should be provided for the extension and completion of the revetment necessary to make the river banks along the city front reasonably safe.

For further details concerning the work in this district see the reports of Capt. James F. McIndoe, Corps of Engineers, U. S. Army, and his assistants, appended hereto.

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PLANT IN THE SEVERAL DISTRICTS.

First and second districts.—This plant is located a short distance below Memphis when not in active service. During the spring and summer of 1904 repair work was actively carried on and the reconstruction of unserviceable plant nearly completed. This work was continued after the end of the working season, and by midsummer the complete outfit will be in effective condition. No new plant has been purchased or built. The small propeller steamer *Unique*, purchased last spring, has been used for inspection and survey purposes, and has given good service. It is of convenient size, has good speed, maneuvers very easily, and is generally effective, but the engine is perhaps too light for the 200 horsepower developed.

For further details relative to plant in the first and second districts reference is made to the reports of Capt. E. W. Van C. Lucas and Assistant Engineer A. J. Nolty, hereto appended.

Third district.—The plant pertaining to the third district is cared for at Greenville, Miss., when not in use. Extensive repairs were made during the season, and the plant has been maintained in good condition. The new steel-hull towboat was delivered by the contractors on July 31, 1904.

For further details respecting plant in the third district reference is made to the report of Capt. Geo. M. Hoffman, hereto appended.

Fourth district.—The plant pertaining to the fourth district is cared for at New Orleans, La. General repairs to the entire plant have been made, and it is now, with the exception of such parts as are worn out, in good condition. During the year ten standard gunwale barges built under contract have been delivered, and four unserviceable barges have been inspected, condemned, and sold. A small steel-hull stern-wheel steamer has also been built under contract and was delivered on May 29, having been delayed by ice and obstructed navigation in the Wisconsin River, through which she had to pass.

For further details of the plant in the fourth district reference is made to the report of Capt. James F. McIndoe, hereto appended.

Other plant.—The steamer *Mississippi*, used for the inspection trips of the Commission, the steamers and quarter boat used in the general surveys, and the dredges, with the steamers, towboats, pile sinkers, and barges used in connection with the dredging operations, are cared for at West Memphis, Ark., where a general supply and repair depot has been established. Extensive repairs have been made during the year and the plant maintained in good condition. Two small barges have been built to replace others that had become unserviceable. The tenth hydraulic dredge, to be called the *B. M. Harrod*, has been placed under contract and the work of her construction has begun.

LEVEES.

For convenience in administration and the allotment of funds for levee purposes the river front has been divided by the Commission into levee districts. As now constituted these districts are named and located as follows:

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Name of district.	Miles below Cairo.[a]	Bank of river.	State.	Engineer district.
Upper St. Francis	0 to 70	Right	Missouri	First.
Reelfoot	37 to 58	Left	Kentucky and Tennessee	Do.
Lower St. Francis	79 to 298	Right	Missouri and Arkansas	First and second.
Upper Yazoo	[b]243 to 365	Left	Mississippi	Second.
White River	306 to 385	Right	Arkansas	Do.
Lower Yazoo	365 to 594	Left	Mississippi	Third.
Upper Tensas	(c) to 607	Right	Louisiana	Do.
Lower Tensas	607 to 764	do	do	Fourth.
Atchafalaya	(d) to 886	do	do	Do.
Pontchartrain	884 to 960	Left	do	Do.
Lafourche	886 to 968	Right	do	Do.
Lake Borgne	972 to 1,063	Left	do	Do.
Barataria	982 to 1,063	Right	do	Do.

[a] Distances below Cairo are given as shown on "inch to the mile" map of the lower Mississippi River, edition of 1881–1897.

[b] The upper end of this levee system joins the hills to the west of Horn Lake about 4 miles from the river.

[c] The continuous levee system of this district at present begins on the north bank of Amos Bayou, about 7 miles south of Arkansas River, and thence runs down the bank of Amos Bayou and Cypress Creek about 13 miles to Lucca Landing on the Mississippi River, 427 miles below Cairo. The levee on the south bank of Arkansas River extends about 16 miles below Red Fork (a point on that river due north of the upper end of the levee on Amos Bayou) and to that extent overlaps the continuous system.

[d] The upper end of the Mississippi River levee system of this district is at Barbre Landing on Old River, where it joins the levee running down the east bank of Atchafalaya River. From Barbre Landing it follows Old River 6 miles to Torras Landing on the Mississippi River, 765 miles below Cairo.

The Annual Report of the Commission for 1904 (pp. 20–23) contains a full description of these districts. The reports of the officers in charge of the several engineer districts, appended hereto, also give detailed information regarding their present condition and requirements and of the work done for levee improvement during the past year.

Details as to the contracts entered into and the work done thereunder are given in the above-mentioned reports of the district officers.

The season has been generally favorable for carrying on levee work, and the improvement accomplished is satisfactory and important. During the summer, autumn, and early winter there was less hindrance to the work from excessive rains than generally occurs, while the moderate flood stages of the river have allowed it to go on at most places without interruption throughout the usual period of high water. In some localities a scarcity of labor has been noted, though this appears not to have retarded the work as a whole.

The method of moving earth for the building and enlargement of levees remains as heretofore—almost entirely by the use of mules and scrapers—though in a few instances power-driven machinery has been successfully used, generally of the type of clam-shell dredges with long booms, carried on tracks by land or sometimes floated on pontons, and the occasional employment of men with spades and wheelbarrows is not yet wholly obsolete.

The dimensions and proportions of the levees built and enlarged and the specifications under which the work has been executed have been in substantial accordance with the general requirements prescribed or approved by the Commission, whether done by the local authorities or by the United States under the supervision of the district officers.

No material change from last year's figures appears in the general run of prices at which levee work of like character has been undertaken by contractors, although they have varied somewhat in the different districts.

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The following figures, derived from the appended reports of the district officers, show in tabular form the present condition of the levees and the results of the levee work undertaken during the past year:

Levee districts.	In system.	Built.	Contents, 1904.	Built since by United States.
	Miles.	*Miles.*	*Cubic yards.*	*Cubic yards.*
Upper St. Francis	54.00	16.50	661,002	299,167
Reelfoot	20.00	9.60	789,131	229,630
Lower St. Francis	210.00	210.00	15,249,972	2,411,504
Upper Yazoo	124.00	124.00	22,090,622	758,685
White River	74.00	72.00	8,311,715	859,747
Lower Yazoo	188.60	188.60	35,615,386	1,040,708
Upper Tensas	194.00	190.20	30,784,126	1,675,297
Lower Tensas	160.24	142.76	18,863,026	25,592
Atchafalaya	128.46	128.46	20,165,036	318,219
Pontchartrain	125.64	125.64	15,501,382	961,708
Lafourche	82.16	82.16	8,523,894	242,983
Lake Borgne	77.07	77.07	3,564,796	76,606
Barataria	71.88	71.88	2,972,836	86,906
Total	1,510.05	1,488.87	183,092,924	8,986,652

Levee districts.	Built since by local authorities.	Total built since 1904.	Lost or abandoned during year.	Contents in 1905.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Upper St. Francis	207,615	506,782	.....	1,167,784
Reelfoot	50,000	279,630	.....	1,068,761
Lower St. Francis	823,059	3,234,563	150,000	18,334,535
Upper Yazoo	1,614,615	2,373,250	.....	24,463,872
White River	170,000	1,029,747	220,000	9,121,462
Lower Yazoo	4,246,661	5,287,369	2,997,000	37,906,755
Upper Tensas	660,483	2,335,780	653,600	32,466,306
Lower Tensas	772,287	797,879	316,122	19,344,788
Atchafalaya	863,782	1,182,001	400,200	20,946,837
Pontchartrain	274,133	1,235,841	127,097	16,610,126
Lafourche	52,307	295,240	.....	8,819,184
Lake Borgne	125,189	201,795	54,350	3,712,241
Barataria	187,904	274,810	61,470	3,186,176
Total	10,048,035	19,034,687	4,979,839	197,147,772

Levee districts.	Required to complete.	Estimated final contents.	Percentage now built.
	Cubic yards.	*Cubic yards.*	
Upper St. Francis	4,294,764	5,462,548	21.3
Reelfoot	1,236,653	2,305,414	46.3
Lower St. Francis	6,163,146	24,497,681	74.8
Upper Yazoo	3,204,659	27,668,581	88.3
White River	7,516,756	16,638,218	54.8
Lower Yazoo	13,580,338	51,486,093	73.6
Upper Tensas	16,532,000	48,998,306	66.2
Lower Tensas	12,525,950	31,870,738	60.7
Atchafalaya	4,775,900	25,722,737	81.4
Pontchartrain	5,098,898	21,709,924	76.5
Lafourche	2,585,462	11,404,596	77.3
Lake Borgne	1,412,732	5,124,973	72.4
Barataria	1,196,220	4,382,996	72.7
Total	80,123,478	277,271,250	71.1

The loss of levee by abandonment on account of caving river banks or for other causes, as shown above, amounts to the unusually large volume of 4,979,839 cubic yards, or over 2½ per cent of the contents of the existing levee line. This is largely due to the extensive changes in the location of levees in the Lower Yazoo district, made to cover parts of the line threatened by caving river banks.

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The "estimated final contents" of the levees, as given in the above table, is based upon grades and sections as heretofore provisionally recommended by the Commission. As noted in previous reports, it is still expected that some revision of these tentative grades will be made hereafter as experience may develop their necessity. That the aggregate contents of a completed levee system need be much increased by such revision does not now appear probable. The total contents will undoubtedly be increased in the future by extensions of the system in some localities and by additions to their width and strength where local interests can afford it and are alive to the importance of a larger factor of safety.

Attention is again invited to the fact stated in the last report of the Commission (p. 20, Annual Report of June 30, 1904) that the complete protection of the St. Francis Basin against overflow from the Mississippi River depends upon the integrity of the levee line above Birds Point, opposite the mouth of the Ohio, and thence extending up to the bluffs near Commerce, and across the lowlands between Grays Point and Cape Girardeau. The acts making appropriations for improving the Mississippi River under the plans of the Commission are now limited in their application—so far as levee building is concerned—to that stretch of river from the Head of the Passes to the mouth of the Ohio River. The recommendation is renewed that express authority be given by law for the allotment and expenditure of funds for levee work on that part of the river front in the State of Missouri from the mouth of the Ohio to the highlands in the vicinity of Cape Girardeau.

Bayou Lafourche, a narrow outlet of the Mississippi, now closed by a temporary dam flowed through the right bank of the river at Donaldsonville, 886 miles below Cairo, and after a course of 110 miles emptied into the Gulf of Mexico. It derived its entire water supply from the Mississippi, the greatest measured discharge being about 32,000 cubic feet per second. It was only navigable by shallow-draft flatboats during seasons of low water, though at high and medium stages coal boats from the Mississippi entered it and regular lines of steamboats carried on its commerce.

Its banks are thickly peopled and highly cultivated, and levees on both sides for 70 miles or more down the bayou have been built and continually enlarged ever since the coming of the earlier settlers. But the levees have never proved adequate to control any of the larger floods, the normal condition at every high water in the Mississippi having always been that on one side or the other, or more often on both, the levees were overtopped or broken and disastrous overflow ensued.

For this reason the closure of the bayou has been proposed and officially recommended time and again for the past fifty years, until finally authority was granted by Congress and the State legislature to build a dam across the head of the bayou pending the construction of a lock which the levee boards were authorized to build. They were also required to provide a channel 60 feet wide and 6 feet deep throughout the bayou.

The dam was accordingly built during the winter of 1903–4, but under the requirements of existing laws must be removed on or before December 13, 1907.

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The dam is an earthen embankment similar to the dikes or levees crossing other bayous, and now forms a part of the levee system on the Mississippi River. No effect in raising the flood level of the Mississippi has been discovered, though it has closed the outlet during two flood seasons. So long as the dam remains it excludes all flood waters from the bayou, and thus prevents the danger of overflow from the failure of the bayou levees and avoids the immense outlay formerly required in the attempts to maintain them, which official reports show to have been over $1,250,000 during the ten years preceding the closure of the bayou. The money formerly required for work on the Lafourche levees, and that would again be required were the dam removed, could be more effectively expended on the levees of the Mississippi.

The levee boards have been prosecuting the work of dredging a 6-foot channel in the bayou ever since the building of the dam, and have found it a costly undertaking. They have not yet been able to begin the construction of a lock, and it appears evident that if now begun it could not be completed before the date prescribed by existing laws for the removal of the dam.

It is therefore believed that in the interest of protection from floods the laws should be so amended as to permit the dam to remain, at least until the people who may be directly benefited by the resumption of navigation find it profitable to build a lock to again connect the bayou with the river.

The local levee districts created under the laws of the various States bordering the Mississippi River practically include all the river front of the levee districts, as designated by the Commission and heretofore referred to. The local districts, however, are not, in most cases, coterminous with the Commission's districts, nor always identical in name.

There are at present more than twenty of these local levee districts organized for the maintenance of levees on the Mississippi River, with boards of commissioners empowered to raise and administer funds for the purpose.

The means used for raising revenue differ somewhat in the various districts, though in each one of them some one or more of the following methods are authorized, viz, (1) direct ad valorem taxes, (2) privilege taxes, (3) assessments per acre upon lands, (4) assessments per mile on railroads, (5) forced contributions on products of the soil shipped out of the districts, such as cotton, sugar, rice, and esculents (which in lower Louisiana include oysters), and (6) the issue and sale of district bonds.

In response to a recent circular of inquiry concerning the names, location, means, revenues etc., of the various levee districts, information has been supplied relative to most of them.

The official or legal names of these local levee districts, so far as ascertained, and their location on the river front, with reference to the levee districts as designated by the Commission, are as follows:

1. *Levee district No. 1, Mississippi County, Mo.*, 0 to 45 miles below Cairo, included in Upper St. Francis levee district.
2. *Reelfoot levee district, Kentucky and Tennessee*, 37 to 58 miles below Cairo, same front as Commission's Reelfoot levee district.
3. *St. Francis levee district of Missouri*, 79 to 128 miles below Cairo, included in Lower St. Francis levee district.

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4. *St. Francis levee district of Arkansas*, 128 to 298 miles below Cairo, included in Lower St. Francis levee district.
5. *Yazoo-Mississippi Delta levee district*, 243 to 365 miles below Cairo, same front as Commission's Upper Yazoo levee district.
6. *Cotton Belt levee district, Arkansas*, 306 to 335 miles below Cairo, included in White River levee district.
7. *Laconia levee district, Arkansas*, 335 to 385 miles below Cairo, included in White River levee district.
8. *Mississippi levee district, Mississippi*, 365 to 580 miles below Cairo, included in Lower Yazoo levee district.
9. *Red Fork levee district, Arkansas*, 402 to 427 miles below Cairo, included in Upper Tensas levee district.
10. *Desha levee district, Arkansas*, 427 to 442 miles below Cairo, included in Upper Tensas levee district.
11. *Chicot levee district, Arkansas*, 442 to 520 miles below Cairo, included in Upper Tensas levee district.
12. *Tensas Basin levee district, Louisiana*, has no front on Mississippi River, but embraces territory north of Red River between Bayou Maçon, Tensas and Black rivers, on the east and the highlands west of the Ouachita. Its principal overflow comes from water escaping from the Mississippi and Arkansas rivers in Desha and Chicot counties, Ark., and it is organized for the purpose of aiding in the maintenance of levees in these counties.
13. *Fifth Louisiana levee district, Louisiana*, 520 to 764 miles below Cairo, partly in Upper Tensas levee district and partly in Lower Tensas levee district.
14. *Atchafalaya Basin levee district, Louisiana*, 765 to 886 miles below Cairo, same front as Commission's Atchafalaya levee district.
15. *Pontchartrain levee district, Louisiana*, 834 to 960 miles below Cairo, same front as Commission's Pontchartrain levee district.
16. *Lafourche levee district, Louisiana*, 886 to 1,020 miles below Cairo, except city of New Orleans (962 to 982 miles below Cairo); upper part included in Commission's Lafourche levee district and lower part in Commission's Barataria levee district.
17. *Orleans levee district, Louisiana*, on both sides of the river, on right bank 968 to 982 and on left bank 960 to 972 miles below Cairo; not included in Commission's levee districts.
18. *Lake Borgne levee district, Louisiana*, 972 to 1,019 miles below Cairo, included in Commission's Lake Borgne levee district.
19. *Grand Prairie levee district, Louisiana*, 1,019 to 1,052 miles below Cairo, included in Lake Borgne levee district.
20. *Buras levee district, Louisiana*, 1,020 to 1,053 miles below Cairo, included in Barataria levee district.

Distances below Cairo are given above to the nearest miles as shown on Commission's inch-to-mile maps, edition 1881–1897.

No replies were received from four of the above-named districts in Missouri and Arkansas, but from statements supplied by officials of the other districts the following figures relative to their means, revenues, and expenditures have been compiled and tabulated.

The statements furnished by Messrs. H. N. Pharr, chief engineer St. Francis levee district of Arkansas; T. G. Dabney, chief engineer Yazoo-Mississippi Delta levee district; C. H. West, chief engineer Mississippi levee district, and F. M. Kerr, chief State engineer, Louisiana, contain much additional detail as to the levee districts in their charge, and are appended hereto. (See Appendix C.)

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No. as above.	District.	Total valuation of property taxable or assessable for levee purposes.	Total annual revenue for levee purposes from taxes or assessments.	Amount paid or due for levee construction and maintenance, and for right of way, legal or incidental expenses, during year.	Amount of bonded or other interest-bearing debt.
2	Reelfoot, Ky. and Tenn	$1,700,000	.....	$41,500	$200,000
4	St. Francis, of Arkansas	20,000,000	$122,935	291,468	1,250,000
5	Yazoo-Mississippi Delta, Miss	26,942,368	425,866	680,323	1,654,000
7	Laconia, Ark	1,000,000	[a] 4,500	24,000	.....
8	Mississippi, Miss	18,071,268	390,580	1,273,477	2,150,000
9	Red Fork, Ark	79,862	7,966	17,000	.....
11	Chicot, Ark	1,250,000	12,500	14,085	5,000
12	Tensas Basin, La	4,107,227	[b] 20,536	39,866	78,000
13	Fifth Louisiana, La	6,962,290	200,473	571,496	737,897
14	Atchafalaya Basin, La	16,615,087	264,151	391,611	850,000
15	Pontchartrain, La	7,496,370	110,169	149,633	851,000
16	Lafourche, La	11,423,739	188,109	142,798	500,000
18	Lake Borgne, La	2,019,197	28,565	31,491	100,000
19	Grand Prairie, La	194,755	6,097	13,849	30,000
20	Buras, La	490,018	8,515	16,362	35,000
	Total	118,352,131	1,790,982	3,698,904	8,440,897

[a] $21,000 additional derived from sale of lands.
[b] $22,268 additional received from the 1 mill State levee tax ("General Engineer Fund").

NOTES.—The Orleans levee district, which comprises the city of New Orleans, is not included in the above table for the reason that no levee work has been done by the United States in that district. Its valuation on the tax rolls of 1904 was $161,418,964, so that its annual levee tax of 1 mill on the dollar enables it to build and improve its levees without assistance.

In addition to the amounts paid and due by the levee districts, as shown above, the State of Louisiana has paid $313,173 for levee construction in the seven last-named levee districts, making an aggregate expenditure for levee purposes during the past year in the districts included in the above table of $4,012,077. It may also be noted that in Louisiana the right of way for levees, which in other States usually forms a large item of cost, is taken without pecuniary compensation to land owners. Presumably, if paid for it would be as costly there as elsewhere, so that its value, if it could be ascertained, might properly be added to the amount locally contributed for levee purposes.

The aggregate of annual revenues derived from taxes and assessments in the levee districts named in the above table applied to the total valuation of the property taxed or assessed shows the average local contribution for the building and preservation of levees to be equivalent to an annual tax of over 1½ per cent, which is, of course, not the same in all the districts and therefore much greater in some of them.

This large tribute, cheerfully paid by the people of the districts, in addition to the taxes levied for other purposes and the extent of the bonded and floating debts they have assumed, sufficiently attests the vital importance to them of levee protection, and the fact that their expenditures on account of levees during the past year have nearly quadrupled the levee allotments from funds appropriated by Congress shows a gratifying continuance of that cooperation which has marked the progress of levee work from the beginning of the assistance supplied by the General Government.

In the last annual report reference was made to the remarkable developments within recent years of the Yazoo Basin in population, railroads, business, values, and general prosperity resulting from the establishment of confidence in security from overflow. In connection

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with this exhibit one gratifying fact can be stated in relation to the levees by which this protection is afforded.

In all the work done upon the levees under the supervision of the Commission the hope has been cherished of an ultimate consummation when the increase of wealth and population in the protected areas would enable the people to maintain their levees, when once completed, without further aid from the Government. For the first time in the history of the work this hope was realized in respect to a large and important area in the allotments for the fiscal year 1905–6. No allotment was made for the Upper Yazoo levee district because it was thought that, for the present at least, the people of that district were able to take care of themselves. This district is about 3,281 square miles in area and is protected by a single line of levees 124 miles in length. Its levees have had in the past to stand a severe strain from return of overflow water from the St. Francis Basin in great floods. The district is strong in its financial resources, and its levee have been built with the highest skill and judgment. The Commission thought it an opportune time and place to try the experiment of withdrawing the supporting hand of the Government.

THE ST. FRANCIS BASIN.

The conditions in the St. Francis Basin exhibit, even more remarkably than those in the Yazoo Basin referred to in the last report of the Commission, the beneficent results of the establishment of confidence in security from overflow afforded by the maintenance of the levees. This part of the alluvial valley lies at its head, immediately below Cairo; or, with more exact truth, immediately below Commerce, a point some 41 miles above Cairo, to which a prolongation of the St. Francis Basin extends. It has an area of 6,700 square miles and a river front of 348 miles. A considerable part of its surface is within the area affected by the earthquakes of 1811–12, which produced the "sunken lands" of that country. It is drained by the St. Francis River, whose channel winds its way down the central part of the basin in a complicated succession of bends.

Ten years ago this great area was substantially an unbroken wilderness. It had not the comparatively high interior ridges of the Yazoo Basin, which made part of that country accessible and tillable even without protection from overflow, subject, of course, to shallow inundation in times of great flood. The swamps of the St. Francis Basin were so low and extensive that over the greater part of its area roads and cultivation were both impossible. It contained vast stores of timber, but with no means of getting it out. Drainage on any small scale was impossible for want of outlets. The value of land was scarcely more than nominal. Upon such a basis of revenue the building of levees adequate to the protection of the basin by the unaided resources of the people was impossible. But for the assistance of the United States in that work the country must have remained a wilderness for generations to come.

Partly because it was thought best for general reasons to carry the reconstruction of the levee system which has been going on with the cooperation of the Government for twenty years past, from the lower parts of the river upward, and partly because of the unreadiness of the people of the St. Francis Basin to cooperate effectively in the

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work, comparatively little money was expended under the recommendation of the Commission on the St. Francis levees until within a few years past. When it was seen that the time was coming for the Government to extend its aid, and that it certainly would do so, the citizens were aroused to the highest activity. The enactment of laws was procured granting to the people large powers of self-taxation for levee purposes, and these were freely used to the limit of the ability of the taxpayers. As the construction of the levees progressed the value of lands went up; railroads were multiplied, the present mileage being about 1,025, with other lines projected; the lumber industry expanded with explosive suddenness, and the whole basin became a theater of most intense activity. In such a country the first step in its development is the removal of the timber. Half a century ago this process in a country as heavily timbered as the St. Francis Basin consumed the lives of the first generation of pioneers, and the timber was mostly burned up. In the clearing of the St. Francis Basin now going on nothing is wasted. Every tree has a money value, which is being realized.

When the forests are removed there will remain a country of extraordinary fertility and value. For the production of corn, cotton, grasses, alfalfa, potatoes, and other crops it has no superior.

After protection from overflow the one thing necessary to the full development of the country is drainage. And this is being provided in the most effective manner. The map of the St. Francis Basin accompanying this report has been made mostly to exhibit the system of drainage canals now in course of excavation in the basin. The plan in execution contemplates the shortening of the St. Francis River by straightening its channel and the discharge into it of a system of canals sufficient in number, capacity, and fall to completely drain the entire basin. Careful surveys have shown the work to be entirely feasible. With an efficient maintenance of the levees there is no reasonable doubt of the completion of the canal system. With it the St. Francis Basin will become a region which may well be named the Egypt of the New World. In all the history of the alluvial basin no more striking example of the value of the levee system is to be found than in this basin.

Respectfully submitted.

O. H. ERNST,
Colonel, Corps of Engineers, U. S. Army,
President, Mississippi River Commission.

R. S. TAYLOR.
J. A. OCKERSON.
THOS. L. CASEY,
Major, Corps of Engineers, U. S. Army.

CLINTON B. SEARS,
Lieut. Col., Corps of Engineers, U. S. Army.

HENRY B. RICHARDSON.
HOMER P. RITTER,
Assistant, U. S. Coast and Geodetic Survey.

Brig. Gen. A. MACKENZIE,
Chief of Engineers, U. S. A.

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Money statements.

Appropriations expended under Mississippi River Commission.

[Appropriation for improving Mississippi River.]

July 1, 1904, balance unexpended		[a]$2,716,070.02
Amount appropriated by sundry civil act approved March 3, 1905	$2,000,000.00	
Amount appropriated by river and harbor act approved March 3, 1905	1,000,000.00	
Miscellaneous receipts from transfers and sales of Engineer property under the provisions of section 5 of river and harbor act of June 13, 1902, and other sources	8,215.45	
		3,008,215.45
		5,724,285.47
June 30, 1905, amount expended during fiscal year		2,210,645.05
July 1, 1905, balance unexpended		3,513,640.42
July 1, 1905, outstanding liabilities	$43,916.22	
July 1, 1905, amount covered by uncompleted contracts	561,151.30	
		605,067.52
July 1, 1905, balance available		2,908,572.90
Distributed as follows:		
Mississippi River Commission		2,208.07
Surveys, gauges, and observations		6,613.29
Levees		672,938.16
Revetment and contraction works, permanent channel improvements and protection		201,796.84
Plant and miscellaneous		530.71
Improving harbors and tributaries		22,985.83
Unalloted		2,001,500.00
		2,908,572.90

Amounts necessary to be appropriated for the fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905.

For continuing the improvement of the Mississippi River from Head of Passes to the mouth of the Ohio River, including salaries and clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission	$3,000,000.00
For protection of banks at or near Caruthersville, Mo	25,000.00
Improving harbor at Memphis, Tenn. (including Wolf River)	25,000.00
Improving harbor at Helena, Ark	25,000.00
Improving harbor at Natchez, Miss., and Vidalia, La	200,000.00
Rectification of Red and Atchafalaya rivers, Louisiana	50,000.00
Improving harbor at New Orleans, La	300,000.00
	3,625,000.00

[Appropriation for gauging waters of Mississippi River and its tributaries.[b]]

July 1, 1904, balance unexpended	$2,766.08
Amount alloted by Chief of Engineers, August 11, 1904, from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, as amended by section 9 of river and harbor act of June 13, 1902	9,100.00
	11,866.08

[a] The amount, $2,716,068.18, reported in Annual Report for 1904, was increased $1.84 during fiscal year by following refundments of overpayments by third district officer:

Allotment for Lower Yazoo levee district	$0.70
Allotment for plant	1.14
	1.84

[b] The custody and care of the gauges maintained under this appropriation were assumed by the Mississippi River Commission February 11, 1901, on which date they were transferred to the secretary, under authority of Secretary of War, dated January 25, 1901.

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June 30, 1905, amount expended during fiscal year	$9,749.99	
June 30, 1905, amount reverted to Treasury during fiscal year	436.58	
		$10,186.57
July 1, 1905, balance unexpended		1,679.51
July 1, 1905, outstanding liabilities		1,240.05
July 1, 1905, balance reverting to Treasury		439.46
Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905		9,100.00

[Appropriation for waterway from Lockport, Ill., to St. Louis, Mo.]

July 1, 1904, balance unexpended	$9,153.55
Amount transferred from allotment for "Survey of Illinois and Des Plaines Rivers, Ill.," as reimbursement	1,093.40
	10,246.95
June 30, 1905, amount expended during fiscal year	6,428.64
July 1, 1905, balance unexpended	3,818.31
July 1, 1905, outstanding liabilities	17.05
July 1, 1905, balance available	3,801.26

[Appropriation for emergencies in river and harbor works.]

Amounts allotted from appropriation by act of April 28, 1904—	
For Wolf River	$8,000.00
For Giles Bend, Miss	40,000.00
	48,000.00
June 30, 1905, amount expended during fiscal year	48,000.00

[Appropriation for examinations, surveys, and contingencies of rivers and harbors.]

Amounts allotted from appropriation by river and harbor act of March 3, 1905, for Ashport, Tenn	$485.00
July 1, 1905, balance unexpended	485.00
July 1, 1905, balance available	485.00

Consolidated statement of all appropriations expended under the Mississippi River Commission to June 30, 1905.

[Appropriation for improving Mississippi River.]

Act of June 28, 1879 (organic)	$175,000.00
Act of June 16, 1880 (sundry civil)	150,000.00
Act of March 3, 1881 (river and harbor)	1,000,000.00
Act of March 3, 1881 (sundry civil)	150,000.00
Act of August 2, 1882 (river and harbor)	4,123,000.00
Act of August 7, 1882 (sundry civil)	150,000.00
Act of March 3, 1883 (sundry civil)	150,000.00
Act of January 19, 1884 (river and harbor)	1,000,000.00
Act of July 5, 1884 (river and harbor)	75,000.00
Act of July 5, 1884 (river and harbor), less $5,000 transferred to snag-boat service	2,065,000.00
Act of July 7, 1884 (sundry civil)	75,000.00
Act of August 5, 1886 (river and harbor), less $5,942.60 for expenses, office Chief of Engineers	1,994,057.40
Act of August 5, 1886 (river and harbor), less $47.30 for expenses, office Chief of Engineers	29,952.70
Act of August 11, 1888 (river and harbor), less $4,859 for expenses, office Chief of Engineers	2,840,141.00
Act of August 11, 1888 (river and harbor)	75,000.00

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Act of October 2, 1888 (sundry civil)		$35,000.00
Act of October 19, 1888 (deficiency), less $4,214.39 reverted to the Treasury		20,785.61
Act of September 19, 1890 (river and harbor)		3,200,000.00
Act of September 30, 1890 (deficiency)		5,625.00
Act of March 3, 1891 (deficiency)		1,950.00
Act of March 3, 1891 (joint resolution)		1,000,000.00
Act of July 13, 1892 (river and harbor)		2,470,000.00
Act of July 28, 1892 (deficiency)		44.80
Act of March 3, 1893 (sundry civil)		2,665,000.00
Act of August 18, 1894 (river and harbor)		485,000.00
Act of August 18, 1894 (sundry civil)		2,665,000.00
Act of March 2, 1895 (sundry civil)		2,665,000.00
Act of June 3, 1896 (river and harbor)		909,000.00
Joint resolution approved March 31, 1897 (Public, No. 6)		250,000.00
Act of June 4, 1897 (sundry civil)		2,933,333.00
Act of July 19, 1897 (deficiency)		625,000.00
Act of July 1, 1898 (sundry civil)		1,983,333.00
Act of March 3, 1899 (sundry civil)		2,583,333.00
Act of March 3, 1899 (river and harbor)		185,000.00
Act of June 6, 1900 (sundry civil), less $5,000 for expenses, office Chief of Engineers		2,245,000.00
Act of June 13, 1902 (river and harbor)		90,000.00
Act of June 13, 1902 (river and harbor)		2,200,000.00
Act of March 3, 1903 (sundry civil)		2,000,000.00
Act of April 28, 1904 (sundry civil)		2,000,000.00
Act of March 3, 1905 (river and harbor)		1,000,000.00
Act of March 3, 1905 (sundry civil)		2,000,000.00
Total specific appropriations		50,269,555.51
Balances from former appropriations applied to works below Cairo under act of August 2, 1882, less $123.42 reverted to Treasury	$272,504.96	
Same for works above Cairo, under act of July 5, 1884	22,632.53	
Total balances		295,137.49

MISCELLANEOUS RECEIPTS.

Previously reported	$16,307.85	
Amount collected by the Solicitor of the Treasury from the Memphis and Arkansas City Packet Company as reimbursement for loss of coal from sinking of coal barge by steamer *Kate Adams* on December 27, 1904. Credited to "Dredges and dredging," secretary's office, April, 1905	78.00	
Amount received from Chicago, Burlington and Quincy Railroad Company, for loss of United States property shipped on Government bill of lading No. 70, August 29, 1903, from Minnesota Transfer, Minn., to St. Louis, Mo. Credited to "Surveys, gauges, and observations," secretary's office, May, 1905	11.00	
Amount collected by the Solicitor of the Treasury from the bondsmen of Thomas Worthington, contractor. Credited to "Lower Yazoo levee district," third district office, February, 1905	1,032.28	
Amounts received from sales, transfers, etc., under the provisions of section 5 of river and harbor act of June 13, 1902:		
By secretary—		
Reimbursement for transfer, credited to "Dredges and dredging," October, 1904	3,000.00	
From sales in October, 1904, credited to "Dredges and dredging," December, 1904	35.00	
From sales in December, 1904, credited to "Dredges and dredging," January, 1905	16.00	
From sales in March, 1905, credited to "Dredges and dredging," April, 1905	90.60	

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Amounts received from sales, transfers, etc.—Continued.		
By first and second district officer—		
From sales in January, 1905, credited to "Plant," January, 1905	$1,275.42	
From sales in February, 1905, credited to "Plant," March, 1905	68.00	
From sales in March, 1905, credited to "Plant," April, 1905	46.75	
By third district officer—		
From sales in January, 1905, credited to "Plant," January, 1905	1,414.10	
From sales in May, 1905, credited to "Plant," June, 1905	129.50	
By fourth district officer—		
From sales, credited to "Plant," July, 1904	239.92	
From sales, credited to "Plant," January, 1905	205.63	
From sales, credited to "Plant," March, 1905	55.00	
From sales, credited to "Plant," May, 1905	290.00	
From sales, credited to "Plant," June, 1905	228.25	
Total miscellaneous receipts		$24,523.30
Total		50,589,216.30

EXPENDED.

Location and object.	To June 30, 1904.	During year ending June 30, 1905.	Total.
Mississippi River Commission	$713,211.77	$29,761.79	$742,973.56
Surveys, gauges, and observations	2,086,932.59	89,847.23	2,176,779.82
Levees	[a]18,377,971.87	1,086,707.62	19,464,679.49
Revetment and contraction works, permanent channel improvements and protection	10,661,133.61	373,669.89	11,034,803.50
Dredges and dredging	3,297,649.66	313,656.22	3,611,305.88
Experimental dikes	100,000.00		100,000.00
Plant and miscellaneous	[b]2,222,463.81	187,742.58	2,410,206.39
Improving harbors and tributaries, except Vicksburg Harbor	6,084,954.01	129,259.72	6,214,213.73
Improving Vicksburg Harbor	582,980.98		582,980.98
Works above Cairo	737,632.53		737,632.53
Total expended	44,864,930.83	2,210,645.05	47,075,575.88
Balance unexpended June 30, 1905			1,512,140.42
Unallotted			2,001,500.00
Total appropriated, etc.			50,589,216.30

[a] The amount, $18,377,972.57, reported in Annual Report for 1904 was reduced during fiscal year by refundment of overpayment of 70 cents by third district officer in allotment for Lower Tensas levee district.

[b] The amount, $2,222,464.95, reported in Annual Report for 1904 was reduced during fiscal year by refundment of overpayment of $1.14 by third district officer in allotment for plant.

[Appropriation for gauging waters of the Mississippi River and its tributaries.]

Allotments from general appropriations for examinations, surveys, and contingencies of rivers and harbors by acts of—	
March 3, 1871	$5,000.00
June 10, 1872	5,000.00
March 3, 1873	5,000.00
June 23, 1874	5,000.00
March 3, 1875	5,000.00
Specific appropriations by river and harbor acts of—	
August 14, 1876	5,000.00
June 18, 1878	5,000.00
March 3, 1879	5,000.00
June 14, 1880	5,000.00
March 3, 1881	5,000.00
August 2, 1882	5,000.00

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Deficiency act of March 12, 1884	$2,100.00
Specific appropriations by river and harbor acts of—	
July 5, 1884	5,000.00
August 5, 1886	5,000.00
Allotted from specific appropriation by river and harbor act of August 11, 1888	8,700.00
Deficiency act of October 19, 1888	3,600.00
Allotments from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, for fiscal years, viz:	
1890	9,000.00
1891 (less $3,518.34 withheld in United States Treasury under ruling that only $6,000 can be expended each fiscal year)	5,181.66
1892	5,100.00
1893	5,500.00
1894	5,500.00
1895	5,500.00
1896	5,500.00
1897	5,500.00
1898	5,500.00
1899	6,000.00
1900	5,500.00
1901	6,000.00
1902	6,000.00
Allotments from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, as amended by section 9 of river and harbor act of June 13, 1902, for fiscal years, viz:	
1903	9,100.00
1904	9,100.00
1905	9,100.00
Total	182,481.66

EXPENDED.

	To June 30, 1904.	During year ending June 30, 1905.	Total.
Expenditures	$162,256.37	$9,749.99	$172,006.36
Unexpended balances reverted to Treasury	8,359.21	436.58	8,795.79
Total	170,615.58	10,186.57	180,802.15
Unexpended balance June 30, 1905			1,679.51
Total appropriated, etc.			182,481.66

[Appropriation for waterway from Lockport, Ill., to St. Louis, Mo.]

Act of June 13, 1902 (river and harbor)	$25,000.00
Amount transferred from allotment for "Survey or Illinois and Des Plaines Rivers, Ill.," as reimbursement	1,093.40
Total	26,093.40

EXPENDED.

	To June 30, 1904.	During year ending June 30, 1905.	Total.
Expenditures	$15,846.45	$6,428.64	$22,275.09
Unexpended balance June 30, 1905			3,818.31
Total appropriated, etc.			26,093.40

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[Appropriation for emergencies in river and harbor works.]

Allotments from appropriation by act of April 23, 1904—	
For Wolf River	$8,000.00
For Giles Bend, Miss	40,000.00
	48,000.00
Expended to June 30, 1905	48,000.00

[Appropriation for examinations, surveys, and contingencies of rivers and harbors.]

Allotments from appropriation by river and harbor act of March 3, 1905, for Ashport, Tenn	485.00
Unexpended balance June 30, 1905	485.00

SECRETARY MISSISSIPPI RIVER COMMISSION.

[Appropriations: Improving Mississippi River; gauging waters of the Mississippi River and its tributaries; waterway from Lockport, Ill., to St. Louis, Mo.]

	Appropriation for improving Mississippi River, allotment for—				
	Mississippi River Commission.	Surveys, gauges, and observations.	Dredges and dredging.	Expended allotments.	Total.
Amount expended on previous projects	$238,110.74	$855,247.37			$1,093,358.11
Amount expended on present project to end of last fiscal year	475,101.03	923,292.27	$2,907,045.55	a$46,131.14	4,351,569.99
Balance unexpended at end of last fiscal year	2,387.97	22,643.06	176,057.75		201,088.78
Amount appropriated or allotted since (net)	30,000.00	60,039.50	300,333.95		390,373.45
	32,387.97	82,682.56	476,391.70		591,462.28
Amount expended from beginning of present fiscal year to end of previous month	26,263.34	b 69,770.16	302,896.95		398,930.45
Amount expended during the month	3,498.45	4,285.01	10,759.27		18,542.73
	29,761.79	74,055.17	313,656.22		417,473.18
Balance unexpended at end of month	2,626.18	8,627.39	162,735.48		173,989.05
In Treasury United States	2,508.09	5,000.00	121,752.20		129,260.29
In hand	118.09	3,627.39	40,983.28		44,728.76
	2,626.18	8,627.39	162,735.48		173,989.05
Outstanding liabilities at end of month	418.11	2,362.94	23,228.72		26,009.77
Amount covered by existing contracts at end of month			139,506.76		139,506.76
	418.11	2,362.94	162,735.48		165,516.53
Balance available at end of month	2,208.07	6,264.45			8,472.52

	Appropriation for gauging waters of the Mississippi River and its tributaries.	Appropriation for waterway from Lockport, Ill., to St. Louis, Mo.	Grand total.
Amount expended on previous projects			$1,093,358.11
Amount expended on present project to end of last fiscal year	c $162,256.37	$15,846.45	4,529,672.81
Balance unexpended at end of last fiscal year	2,766.06	9,158.55	213,008.41
Amount appropriated or allotted since (net)	9,100.00	1,093.40	400,566.85
	11,866.06	10,246.95	613,575.26

a Experimental dikes, $45,075.58; patrol of the Mississippi River, $1,055.56.
b Amount formerly reported reduced 1b cents refundment of overpayment suspended by Auditor for the War Department on voucher No. 206, November, 1904.
c Amount formerly reported increased $1.57 in Treasury Settlement No. 23720, August 10, 1908, with Choctaw, Oklahoma and Gulf Railroad Company, for passenger transportation.

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	Appropriation for gauging waters of the Mississippi River and its tributaries.	Appropriation for waterway from Lockport, Ill., to St. Louis, Mo.	Grand total.
Amount expended from beginning of present fiscal year to end of previous month	$8,186.29	$6,428.64	$413,495.38
Amount expended during the month	1,613.70		20,156.43
	9,749.99	6,428.64	433,651.81
Balance unexpended at end of month	[a] 1,679.51	3,818.31	179,486.87
In Treasury United States	1,100.00	1,093.40	131,453.59
In hand	579.51	2,724.91	48,033.18
	1,679.51	3,818.31	179,486.87
Outstanding liabilities at end of month	1,240.05	17.05	27,266.87
Amount covered by existing contracts at end of month			139,506.76
	1,240.05	17.05	166,773.63
Balance available at end of month	439.46	3,801.26	12,713.24

[a] Unexpended balance of $436.58 pertaining to appropriation for fiscal year 1904 reverts to Treasury, and was deposited on October 8, 1904.

WORKS ABOVE CAIRO.

[Appropriation: Improving Mississippi River.]

	Protection near Cairo.[a]	Des Moines Rapids to Ohio River.	Total.
Amount expended on previous projects			
Amount expended on present project to end of last fiscal year	$50,000.00	$687,632.53	$737,632.53
Balance unexpended at end of last fiscal year			
Amount appropriated or allotted since (net)			
Amount expended from beginning of present fiscal year to end of previous month			
Amount expended during the month			
Balance unexpended at end of month			
In Treasury United States			
In hand			
Outstanding liabilities at end of month			
Amount covered by existing contracts at end of month			
Balance available at end of month			

[a] Includes only work under act of July 5, 1884.

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FIRST AND SECOND DISTRICTS.

[Appropriations: Improving Mississippi River; repairing Government levee at Walnut Bend, Ark.; emergencies in river and harbor works.]

	Improving Mississippi River, allotment for—					
	Surveys.	Upper St. Francis levee district.	Lower St. Francis levee district.	White River levee district.	Reelfoot levee district.	Upper Yazoo levee district.
Amount expended on present project to end of last fiscal year	$113,965.57	$59,008.51	$902,210.11	$1,359,711.28	$38,762.97	$1,260,199.54
Balance unexpended at end of last fiscal year	207.54	991.49	49,716.89	16,023.32	1,237.03	46,152.24
Amount appropriated or allotted since (net)	5,000.00	45,000.00	295,000.00	270,000.00	15,000.00	70,000.00
	5,207.54	45,991.49	344,716.89	286,023.32	16,237.03	116,152.24
Amount expended from beginning of present fiscal year to end of previous month	5,197.76	16,115.47	211,046.23	50,844.56	16,235.17	102,815.60
Amount expended during the month	.....	433.86	203.32	329.80	.....	41.34
	5,197.76	16,549.33	211,249.55	51,174.36	16,235.17	102,856.94
Balance unexpended at end of month	9.78	29,442.16	133,467.34	234,848.96	1.86	13,295.30
In Treasury United States	.....	28,000.00	130,000.00	225,000.00	.....	9,000.00
In hand	9.78	1,442.16	3,467.34	9,848.96	1.86	4,295.30
	9.78	29,442.16	133,467.34	234,848.96	1.86	13,295.30
Outstanding liabilities at end of month	.....	300.00	300.00	800.00	.....	200.00
Amount covered by existing contracts at end of month	.....	24,565.00	104,984.80	179,688.20	.....	.....
	.....	24,865.00	105,284.80	180,488.20	.....	200.00
Balance available at end of month	9.78	4,577.16	28,182.54	54,360.76	1.86	13,095.30

	Improving Mississippi River, allotment for—					
	Plum Point reach.	Plant.	At Hickman, Ky.	At New Madrid, Mo.	Caruthersville, Mo.	Hopefield Bend (preservation of works at).
Amount expended on present project to end of last fiscal year	$5,195,313.63	$991,549.73	$94,327.87	$150,312.89	$74,821.02	$228,942.11
Balance unexpended at end of last fiscal year	346.99	2,410.25	804.13	1,687.11	178.98	57.89
Amount appropriated or allotted since (net)	100,000.00	51,469.27	.....	10,000.00	.....	120,000.00
	100,346.99	53,879.52	804.13	11,687.11	178.98	120,057.89
Amount expended from beginning of present fiscal year to end of previous month	[a] 94,778.91	49,140.23	275.50	.....	101.09	119,326.00
Amount expended during the month	5,148.26	3,883.60	.....	.....	.....	661.60
	99,922.17	53,023.83	275.50	.....	101.09	119,987.60

[a] Amount formerly reported reduced $8 on account of error in footing of page 2, voucher 179, November, 1904.

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	Improving Mississippi River, allotment for—					
	Plum Point reach.	Plant.	At Hickman, Ky.	At New Madrid, Mo.	Caruthersville, Mo.	Hopefield Bend (preservation of works at).
Balance unexpended at end of month	424.82	855.69	528.63	11,687.11	77.89	70.29
In Treasury United States		198.85		10,000.00		
In hand	424.82	661.84	528.63	1,687.11	77.89	70.29
	424.82	855.69	528.63	11,687.11	77.89	70.29
Outstanding liabilities at end of month	207.41	855.69				70.29
Amount covered by existing contracts at end of month	217.41					
	424.82	855.69				70.29
Balance available at end of month			528.63	11,687.11	77.89	

	Improving Mississippi River, allotment for—				
	At Memphis, Tenn.	At Helena, Ark.	Improving harbor at Memphis, Tenn. (Wolf River).	Expended allotments.	Total.
Amount expended on present project to end of last fiscal year	$44,622.10	$210,153.84	$14,085.41	a$2,123,878.20	$12,861,864.28
Balance unexpended at end of last fiscal year	377.90	346.66	3,914.59		124,458.01
Amount appropriated or allotted since (net)		10,000.00			991,469.27
	377.90	10,346.66	3,914.59		1,115,922.28
Amount expended from beginning of present fiscal year to end of previous month	377.90	7.95	3,495.39		669,752.76
Amount expended during the month			65.71		10,767.49
	377.90	7.95	3,561.10		680,520.25
Balance unexpended at end of month		10,338.71	353.49		435,402.03
In Treasury United States		9,000.00			411,193.85
In hand		1,338.71	353.49		24,208.18
		10,338.71	353.49		435,402.03
Outstanding liabilities at end of month					2,738.39
Amount covered by existing contracts at end of month					309,455.41
					312,188.80
Balance available at end of month		10,338.71	353.49		123,213.23

a Preservation of works, $54,867.89; Walnut Bend levee, preservation of works at, $28,200; removal of Nonconnah rock, $9,000; dredges and dredging, $388,097.12; Columbus, Ky., $43,750; improving St. Francis River (Walnut Bend levee), $75,000; improving harbor at Memphis, Tenn., $1,425,039.77; improving harbor at Memphis, Tenn. (Wolf River), $45,000; dikes, $54,924.42.

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	Repairing Government levee at Walnut Bend, Ark.	Emergencies in river and harbor works for Wolf River.	Examinations, surveys, and contingencies of rivers and harbors.	Grand total.
Amount expended on present project to end of last fiscal year	$5,010.28			$12,866,874.56
Balance unexpended at end of last fiscal year	84,989.72			209,442.73
Amount appropriated or allotted since (net)		$8,000.00	$485.00	999,954.27
	84,989.72	8,000.00	485.00	1,209,397.00
Amount expended from beginning of present fiscal year to end of previous month	69,470.20	8,000.00		747,222.96
Amount expended during the month	12,958.58			23,726.07
	82,428.78	8,000.00		770,949.03
Balance unexpended at end of month	2,560.94		485.00	438,447.97
In Treasury United States			460.00	411,653.85
In hand	2,560.94		25.00	26,794.12
	2,560.94		485.00	438,447.97
Outstanding liabilities at end of month	560.94			3,294.33
Amount covered by existing contracts at end of month				309,455.41
	560.94			312,749.74
Balance available at end of month	2,000.00		485.00	125,698.23

THIRD DISTRICT.

[Appropriation: Improving Mississippi River.]

	Improving Mississippi River, allotment for—			
	Surveys.	Lower Yazoo levee district.	Upper Tensas levee district.	Ashbrook Neck.
Amount expended on present project to end of last fiscal year	$93,371.27	$3,467,255.31	$4,495,420.20	$652,178.11
Balance unexpended at end of last fiscal year	.60	44,987.08	17,237.60	15.01
Amount appropriated or alloted since (net)	5,000.00	218,532.28	332,500.00	
	5,000.60	263,519.36	349,737.60	15.01
Amount expended from beginning of present fiscal year to end of previous month	5,000.33	125,206.50	220,425.35	14.33
Amount expended during the month		1,799.95	4,067.52	.25
	5,000.33	127,006.45	224,492.87	14.58
Balance unexpended at end of month	.27	136,512.91	125,244.73	.43
In Treasury United States		136,512.91	124,500.00	
In hand	.27		744.73	.43
	.27	136,512.91	125,244.73	.43
Outstanding liabilities at end of month	.27	2,000.00	2,500.00	.43
Amount covered by existing contracts at end of month			13,500.00	
	.27	2,000.00	16,000.00	.43
Balance available at end of month		134,512.91	109,244.73	

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	Improving Mississippi River, allotment for—			
	Lake Providence reach.	Stone.	Repairs to revetment at Lake Providence and general repairs, including quarrying of stone.	Plant.
Amount expended on present project to end of last fiscal year	$3,830,582.87	$269,331.74		$977,904.12
Balance unexpended at end of last fiscal year	38.75	1,768.26		33,446.33
Amount appropriated or allotted since (net)			$67,000.00	[a] 21,699.95
	38.75	1,768.26	67,000.00	55,146.28
Amount expended from beginning of present fiscal year to end of previous month	38.35	531.92	40,094.09	52,247.16
Amount expended during the month		66.50	1,553.94	2,108.24
	38.35	598.42	[b] 41,648.03	54,355.40
Balance unexpended at end of month	.40	1,169.84	25,351.97	790.88
In Treasury United States		1,169.84	22,000.00	285.85
In hand	.40		3,351.97	505.03
	.40	1,169.84	25,351.97	790.88
Outstanding liabilities at end of month	.40	50.00	1,500.00	790.88
Amount covered by existing contracts to end of month				
	.40	50.00	1,500.00	790.88
Balance available at end of month		1,119.84	23,851.97	

	Improving Mississippi River, allotment for—				
	Greenville Miss.	Longwood, Miss.	Lake Bolivar front.	Expended allotments.	Total.
Amount expended on present project to end of last fiscal year	$917,372.75		$151,773.57	[c] $628,980.98	$15,484,170.92
Balance unexpended at end of last fiscal year	180.32				97,673.95
Amount appropriated or allotted since (net)		$185,000.00	50,000.00		879,732.23
	180.32	185,000.00	50,000.00		977,406.18
Amount expended from beginning of present fiscal year to end of previous month	179.21	146,790.43			590,527.67
Amount expended during the month	.94				9,597.34
	180.15	146,790.43			600,125.01
Balance unexpended at end of month	.17	38,209.57	50,000.00		377,281.17
In Treasury United States		35,000.00	50,000.00		369,468.60
In hand	.17	3,209.57			7,812.57
	.17	38,209.57	50,000.00		377,281.17
Outstanding liabilities at end of month	.17	100.00			6,942.15
Amount covered by existing contracts at end of month					13,500.00
	.17	100.00			20,442.15
Balance available at end of month		38,109.57	50,000.00		356,839.02

[a] Includes $129.50 proceeds of sales of engineer property deposited May 19, 1905, under the provisions of section 5 of river and harbor act of June 13, 1902; allotment approved by the Assistant Secretary of War June 1, 1905.

[b] Surveys, $251.80; Ashbrook Neck, $3,685.87; Lake Providence reach, $33,120.29; Greenville, Miss., $4,590.07.

[c] Improving harbor at Vicksburg, Miss., $442,724.77; Delta Point, La., $186,256.21.

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FOURTH DISTRICT.

[Appropriations: Improving Mississippi River; improving harbor of Natchez and Vidalia, Miss. and La.; improving harbor of New Orleans, La.; improving Atchafalaya and Red rivers, La.; emergencies in river and harbor works.]

	Improving Mississippi River, allotment for—				
	Surveys, gauges, and observations.	Lower Tensas levee district.	Atchafalaya levee district.	Lafourche levee district.	Barataria levee district.
Amount expended on present project to end of last fiscal year	$101,056.11	$2,644,953.11	$1,452,321.76	$585,427.41	$345,471.89
Balance unexpended at end of last fiscal year	1,081.03	33,095.83	52,787.90	11,056.51	9,260.98
Amount appropriated or allotted since (net)	5,000.00	195,000.00	70,000.00	55,000.00	30,000.00
	6,081.03	228,095.83	122,787.90	66,056.51	39,260.98
Amount expended from beginning of present fiscal year to end of previous month	5,581.72	19,961.80	67,009.95	37,903.86	22,681.43
Amount expended during the month	12.25	301.23	396.94	3,148.89	240.00
	5,593.97	20,263.03	67,408.89	41,052.75	22,921.43
Balance unexpended at end of month	487.06	207,832.80	55,379.01	25,003.76	16,339.55
In Treasury United States		206,500.00	48,000.00	20,000.00	15,000.00
In hand	487.06	1,332.80	7,379.01	5,003.76	1,339.55
	487.06	207,832.80	55,379.01	25,003.76	16,339.55
Outstanding liabilities at end of month	148.00	297.41			
Amount covered by existing contracts at end of month			6,606.78	2,838.59	
	148.00	297.41	6,606.78	2,838.59	
Balance available at end of month	339.06	207,535.39	48,772.23	22,165.17	16,339.55

	Improving Mississippi River, allotment for—				
	Pontchartrain levee district.	Lake Borgne levee district.	Bondurant.	Kempe Bend revetment.	Plant.
Amount expended on present project to end of last fiscal year	$1,266,801.36	$315,309.14	$35,000.00	$480,994.80	$251,954.40
Balance unexpended at end of last fiscal year	39,033.12	1,885.99		3,005.20	44,956.15
Amount appropriated or allotted since (net)	150,000.00	30,000.00	3,000.00	170,000.00	[a]39,018.80
	189,033.12	31,885.99	3,000.00	173,005.20	83,974.95
Amount expended from beginning of present fiscal year to end of previous month	86,914.63	15,715.25	3,000.00	81,478.91	78,041.22
Amount expended during the month	217.17	221.02		179.00	2,322.13
	87,131.80	15,936.27	3,000.00	81,657.91	80,363.35
Balance unexpended at end of month	101,901.32	15,949.72		91,347.29	3,611.60
In Treasury United States	91,500.00	15,000.00		89,990.01	518.25
In hand	10,401.32	949.72		1,357.28	3,093.35
	101,901.32	15,949.72		91,347.29	3,611.60
Outstanding liabilities at end of month				2,172.83	2,524.89
Amount covered by existing contracts at end of month	85,700.48			459.00	556.00
	85,700.48			2,631.83	3,080.89
Balance available at end of month	16,200.84	15,949.72		88,715.46	530.71

[a] Includes $228.25, proceeds of sales of condemned Engineer property under the provisions of section 5 of river and harbor act of June 13, 1902; allotment approved by the Assistant Secretary of War June 1, 1905.

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	Improving Mississippi River, allotment for—				
	Natchez and Vidalia harbors, Miss. and La.	New Orleans Harbor, La.	Atchafalaya and Red rivers, La.	Expended allotments.	Total.
Amount expended on present project to end of last fiscal year	$331,349.64	$107,585.67	$12,991.14	[a] $136,506.99	$8,067,723.42
Balance unexpended at end of last fiscal year	650.36	6,164.33	2,008.86		204,986.26
Amount appropriated or allotted since (net)			1,000.00		748,018.80
	650.36	6,164.33	3,008.86		953,005.06
Amount expended from beginning of present fiscal year to end of previous month	177.75	627.92	2,766.67		421,861.11
Amount expended during the month	472.61	481.29	242.19		8,236.72
	650.36	1,109.21	3,008.86		430,097.83
Balance unexpended at end of month		5,055.12			522,907.23
In Treasury United States					486,508.26
In hand		5,055.12			36,398.97
		5,055.12			522,907.23
Outstanding liabilities at end of month		2,526.84			7,669.97
Amount covered by existing contracts at end of month		2,528.28			98,689.13
		5,055.12			106,359.10
Balance available at end of month					416,548.13

	Emergencies in river and harbor works for Giles Bend, Miss.	Expended appropriations.	Grand total.
Amount expended on present project to end of last fiscal year		[b] $2,263,601.30	$10,331,324.72
Balance unexpended at end of last fiscal year			204,986.26
Amount appropriated or allotted since (net)	$40,000.00		788,018.80
	40,000.00		993,005.06
Amount expended from beginning of present fiscal year to end of previous month	40,000.00		461,861.11
Amount expended during the month			8,236.72
	40,000.00		470,097.83
Balance unexpended at end of month			522,907.23
In Treasury United States			486,508.26
In hand			36,398.97
			522,907.23
Outstanding liabilities at end of month			7,669.97
Amount covered by existing contracts at end of month			98,689.13
			106,359.10
Balance available at end of month			416,548.13

[a] Preservation of works, $134,000; dredges and dredging, $2,506.99
[b] Improving harbors at Natchez and Vidalia, Miss. and La., $282,252.04; improving harbor at New Orleans, La., $979,639.86; improving Atchafalaya and Red rivers, La., $1,001,709.40.

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PLATE AND LIST OF APPENDIXES ACCOMPANYING THE ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1905.

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Appendix A.

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APPENDIX A.

REPORT OF MISSISSIPPI RIVER COMMISSION, ON 14-FOOT WATERWAY GRAFTON TO ST. LOUIS.

NOTE.—This report is not printed with the report of the Mississippi River Commission for 1905, but will be submitted to Congress in the usual way and printed in document form according to custom after review and report by the Board of Engineers for Rivers and Harbors.

APPENDIX B.

REPORT OF ASSISTANT ENGINEER A. T. MORROW, ON RESULTS OF HYDROGRAPHIC SURVEY, FORT ST. PHILIP TO HEAD OF PASSES, 1903–4.

ST. LOUIS, MO., *February 7, 1905.*

CAPTAIN: I have the honor to submit the following report on the comparison of surveys of the Mississippi River between Fort St. Philip and the Head of the Passes.

The principal surveys used in these comparisons were the general survey by the Mississippi River Commission made in November, 1893, and a special survey made by the Mississippi River Commission in December, 1903, and January, 1904. To these were added cross sections from a special survey of about 2 miles of river in the vicinity of Cubits Gap made in December, 1883, by Assistant Engineer C. Donovan; also channel-line soundings made by the Coast Survey, mostly in 1872 (from Coast Survey chart 194), and a few channel-line depths from a survey made in 1838 by Andrew Talcott. The locations of the mattress sills about the Head of the Pass were transferred from a map in the Chief of Engineer's Report of 1901.

The results of the surveys of 1893 and 1903–4 were platted on a scale of 1:10,000. Each section of the survey of 1893 was compared with the nearest corresponding section of the survey of 1903–4. When the positions of these sections did not correspond, the position of the section for comparison was assumed to be between the two lines and the soundings were projected on this assumed section, care being taken to project the soundings near the banks in lines parallel to the adjacent shore line.

These cross sections were platted on a horizontal scale of 1:10,000 and a vertical scale of 1:240, and have been compared in widths, maximum depths, and areas.

In the vicinity of Cubits Gap 14 sections, from the survey of 1883 above mentioned, were similarly platted and compared.

For the purpose of illustrating more clearly the changes that have taken place in the different localities, groups of consecutive sections embracing from three to ten sections each have been selected and combined into composite sections.

A profile has been made showing maximum depths on the several sections. To this have been added depths on channel line from Coast Survey chart No. 194 and the maximum depths on the sounding lines of 1883 and 1838.

I have not attempted to compare elevations along the top of the right bank of the river, for the reasons that between Fort Jackson and The Jump the dirt has been largely removed from the bank to build levees, and below The Jump, in 1893, the banks were so much covered with drift from the great tidal wave of that year that no very good top of bank elevations were obtained. However, comparisons of elevations of top of left bank were made (surveys of 1893 and 1903–4) at 120 different points, about equally distributed between Fort St. Philip and the Head of the Passes, with the following results: Fifty points between Fort St. Philip and Baptiste Collets Canal show an average increase of elevation of 0.29 of a foot; comparison of 50 points between Baptiste Collets Canal and Cubits Gap gives an increase of 0.35 of a foot; 20 points below Cubits Gap show an increase of 0.75 of a foot; for the entire stretch the 120 points show an average increase of 0.4 of a foot.

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The width of the river was compared on 121 cross sections, showing a decrease of 9 feet. Both surveys were made in the season of low water, but the stage was about half a foot lower at the time of the last survey, which may account for the difference in width.

While at some points there have been noticeable changes in the banks, I think, on the whole, it is safe to say that there has practically been no change in the width of the river.

Comparing the maximum depths on 121 cross sections (surveys of 1893 and 1903–4), there has been a decrease on the average of 9.2 feet, or 10.8 per cent.

Comparing the maximum depths on the cross sections of 1893 with depths measured at the same points to the profile of the channel line taken from the Coast Survey chart, mostly from surveys of 1872, gives an average difference of only one-tenth of a foot.

In a like manner, by comparing average maximum depths on a stretch of about 2 miles, in the vicinity of Cubits Gap, where we have three surveys, we get the following changes: From 1883 to 1893 an increase of 4.1 feet, and from 1893 to 1903 a decrease of 7.9 feet.

Comparing the areas of cross sections (surveys of 1893 and 1903–4) on the whole stretch of river from Fort St. Philip to the Head of the Passes we have a decrease in the average area of 6.2 per cent. On the 2-mile stretch in the vicinity of Cubits Gap, where the cross sections of three surveys were measured, we have from 1883 to 1893 an increase in average area of 4 per cent, and between 1893 and 1903 a decrease of 8.6 per cent.

The latest surveys show that Cubits Gap is rapidly filling up, mostly by the formation of bars on the upper side.

On account of lack of data in the earlier surveys, only a few sections were compared in the Passes, sufficient only to indicate the changes that have taken place. The few comparisons made give the following results:

Pass a Loutre has filled up 8.3 per cent and has cut away 70 meters on the right bank, while the maximum depths have changed but little.

South Pass has increased in average maximum depth by 12.4 feet, and in average area of cross section by 26.5 per cent.

Southwest Pass increased in average maximum depth by 11.5 feet, and decreased in average area of cross section by 1.1 per cent.

On the Coast Survey chart, on the Mississippi River Commission maps, and on the plat of the Donovan survey of 1883 the bottom is given as sand in the main bed of the stream and mud at points near shore. The survey of 1903–4 shows mud bottom over nearly the whole bed of the river, sand appearing at a few points only, near Fort St. Philip and in the Head of South Pass.

This change in the character of the bottom and the large amount of recent sedimentary deposits seem to be the most important features brought out by these comparisons.

A search for the causes of these changes leads to a comparison of the floods in the Mississippi and its tributaries during the years closely preceding the times of the surveys.

An examination of the hydrograph shows that the four successive years immediately preceding the survey of 1893 were years of high water on the lower Mississippi; that during this same period there were comparatively few great floods on the Missouri River, and that a large part of such flood waters as did come from the Missouri River reached the lower Mississippi at times of high water.

During the four years immediately preceding the survey of 1903–4 there was only one period of extreme high water on the lower Mississippi, while there was during the last two years of that period a series of extensive floods in the Missouri River from which the waters mostly reached the lower Mississippi on a falling stage or at comparatively low water.

The changes in the Passes are probably due, in part at least, to the mattress sill placed across the head of Pass a Loutre in 1900.

Respectfully submitted.

A. T. MORROW,
Assistant Engineer

Capt. Wm. B. LADUE,
Corps of Engineers.

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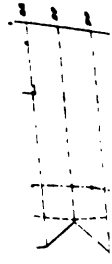

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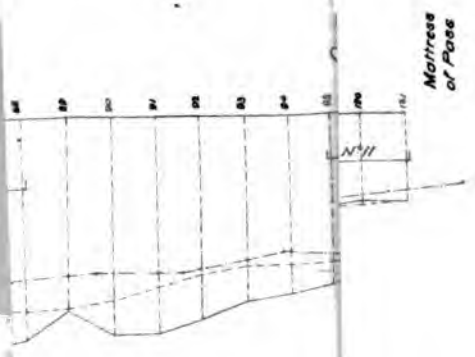

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Comparison of cross-section elements, Cubits Gap and Passes.

SURVEYS OF 1893 AND 1903–4.

[At low water. The low-water plane used in these tables is 0.4 foot below mean Gulf level.]

Number of section.	Width of cross section.		Area of cross section.		Maximum depth at low water.	
	1893.	1903–4.	1893.	1903–4.	1893.	1903–4.
Cubits Gap:	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*
1	3,780	3,494	44,500	42,700	55.0	69.0
2	5,052	4,008	49,500	39,000	45.0	47.0
3	6,348	4,692	49,600	32,800	19.0	12.0
4	7,841	5,709	53,400	27,500	12.0	10.0
Total	23,021	17,898	197,000	142,000	131.0	138.0
Average	5,755	4,474	49,250	35,500	32.8	34.5
Pass a Loutre:						
1	3,258	3,432	102,100	91,700	66.0	63.5
2	3,100	3,336	98,700	93,500	60.0	64.0
3	3,018	3,050	99,500	90,600	71.0	66.5
Total	9,376	9,818	300,300	275,800	197.0	194.0
Average	3,125	3,608	100,100	91,933	65.7	64.7
South Pass:						
1	640	623	16,400	20,300	41.4	51.5
2	830	797	17,200	19,700	31.0	45.0
3	810	830	13,700	19,600	31.0	44.5
4	807	820	14,700	18,800	33.0	45.0
Total	3,087	3,070	62,000	78,400	136.4	186.0
Average	772	768	15,500	19,600	34.1	46.5
Southwest Pass:						
1	2,067	2,011	74,500	72,000	44.0	62.0
2	1,778	1,713	71,900	70,200	54.0	68.0
3	1,683	1,640	71,100	72,400	60.0	72.0
4	1,608	1,575	68,000	67,700	66.0	68.0
Tota'	7,136	6,939	285,500	282,300	224.0	270.0
Average	1,784	1,735	71,375	70,575	56.0	67.5

Comparison of cross-section elements in the vicinity of Cubits Gap, La.

SURVEYS OF 1883, 1893, AND 1903–4.

[At low water. The low-water plane used in these tables is 0.4 foot below mean Gulf level.]

Number of section.	Width of cross section.			Area of cross section.			Maximum depths at low water.		
	1883.	1893.	1903–4.	1883.	1893.	1903–4.	1883.	1893.	1903–4.
	Feet.	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*
95	3,914	3,806	3,789	168,000	180,200	159,700	66.5	73.0	63.5
96	3,953	3,845	3,845	169,700	183,600	159,500	64.5	68.0	60.5
97	3,963	3,898	3,845	164,500	182,200	153,300	64.5	66.0	58.5
98	3,983	3,871	3,881	167,900	181,600	158,500	59.5	63.0	57.0
99	4,015	3,937	3,924	166,000	179,800	152,500	59.5	64.0	54.0
100	4,176	4,127	4,019	168,200	168,000	155,300	55.5	50.0	55.0
101	4,232	4,183	4,068	162,300	157,000	158,000	54.5	50.0	55.0
102	4,216	4,216	4,117	161,400	163,100	157,500	50.5	70.0	54.0
103	4,176	4,085	4,094	152,700	144,300	152,000	49.5	57.0	48.5
104	4,226	4,144	4,045	149,900	142,300	140,800	51.5	54.0	46.5
105	4,272	4,144	4,085	145,900	149,500	135,000	51.5	62.0	44.0
106	4,337	4,239	4,173	152,100	158,400	144,600	50.5	64.0	45.0
107	4,416	4,416	4,252	149,000	161,500	143,200	49.5	64.0	44.5
108	4,409	4,396	4,331	148,000	162,600	145,500	50.5	55.0	45.0
Total	58,288	57,307	56,468	2,225,600	2,314,100	2,115,400	778.0	860.0	731.0
Average	4,163	4,093	4,033	158,971	165,293	151,100	55.6	61.4	52.2

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Comparison of cross-section elements, Fort St. Philip, La., to Head of Passes, La.

SURVEYS OF 1893 AND 1903–4.

[At low water. The low-water plane used in these tables is 0.4 foot below mean Gulf level.]

Number of section.	Width of cross section.		Area of cross section.		Maximum depth at low water.	
	1893.	1903–4.	1893.	1903–4.	1893.	1903–4.
	Feet.	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*
1	2,310	2,389	180,900	177,900	103.5	100.5
2	2,395	2,428	179,200	179,000	100.5	103.0
3	2,205	2,254	179,400	173,900	122.5	116.5
4	2,100	2,165	181,500	194,500	131.5	146.0
5	2,028	2,067	205,600	201,600	151.5	146.5
6	2,080	2,100	198,800	198,000	164.5	151.0
7	2,119	2,100	220,200	190,100	157.5	137.5
8	2,119	2,067	224,300	190,700	156.5	140.0
9	2,018	2,018	181,800	188,700	134.5	125.5
10	2,310	2,205	193,000	180,600	135.5	122.0
11	2,369	2,477	177,400	174,400	138.5	117.5
12	2,506	2,552	179,400	172,500	129.5	117.0
13	2,716	2,756	177,700	166,900	118.5	103.0
14	2,887	2,887	177,000	166,100	105.5	91.5
15	2,848	2,880	179,100	166,800	95.5	88.5
16	2,831	2,854	164,400	160,400	93.5	86.5
17	2,782	2,822	163,800	153,700	94.5	84.0
18	2,667	2,716	160,400	151,300	95.5	83.5
19	2,638	2,658	156,700	138,100	88.5	85.5
20	2,664	2,658	152,900	136,100	87.5	84.5
21	2,543	2,625	147,800	146,000	88.5	84.0
22	2,526	2,543	141,100	145,500	82.5	80.0
23	2,526	2,539	140,600	144,400	83.5	79.0
24	2,592	2,579	145,400	141,800	79.5	78.5
25	2,487	2,585	148,700	141,200	84.5	78.0
26	2,520	2,569	148,400	140,100	82.5	78.5
27	2,506	2,536	149,400	137,600	86.5	77.0
28	2,477	2,510	144,500	133,500	86.5	78.0
29	2,421	2,438	145,400	127,700	85.5	79.0
30	2,388	2,421	146,200	123,300	79.5	79.5
31	2,477	2,395	141,700	138,700	72.5	79.0
32	2,444	2,405	141,500	137,900	72.5	78.5
33	2,477	2,477	146,700	155,800	73.5	78.5
34	2,444	2,503	131,300	153,900	71.5	78.5
35	2,480	2,480	133,900	153,100	67.5	78.5
36	2,480	2,480	135,000	158,100	67.5	77.0
37	2,411	2,461	139,900	153,200	71.5	79.5
38	2,477	2,543	135,200	155,500	64.5	77.5
39	2,480	2,546	137,500	153,600	71.5	77.0
40	2,421	2,428	142,400	152,800	65.5	75.0
41	2,641	2,707	145,800	151,900	64.5	74.0
42	2,716	2,815	161,900	162,900	75.5	74.5
43	2,762	2,795	156,400	153,000	74.5	75.0
44	2,756	2,789	163,500	158,400	72.5	74.0
45	2,677	2,748	156,100	153,800	67.5	71.5
46	2,579	2,579	159,100	153,900	77.5	73.0
47	2,493	2,549	162,300	150,400	83.5	70.5
48	2,372	2,405	153,000	140,800	82.5	69.0
49	2,382	2,421	161,300	141,400	87.5	69.5
50	2,552	2,625	166,500	151,400	84.5	68.0
51	2,569	2,658	166,500	148,400	88.5	67.5
52	2,651	2,674	164,800	151,000	87.5	67.5
53	2,700	2,716	172,000	147,800	93.0	67.0
54	2,880	2,854	174,500	164,700	86.0	67.5
55	3,150	3,061	179,200	176,000	91.0	78.0
56	2,887	2,887	170,000	155,900	99.0	80.0
57	2,822	2,871	163,800	144,300	106.0	80.0
58	2,733	2,756	168,900	144,500	114.0	79.5
59	2,674	2,664	149,800	138,600	110.0	76.0
60	2,690	2,641	154,900	133,900	115.0	82.5
61	2,674	2,697	158,800	142,500	101.0	82.0
62	2,641	2,730	150,800	145,000	100.0	81.0
63	2,585	2,585	148,800	139,100	107.0	81.5
64	2,510	2,510	150,300	136,400	115.0	82.5
65	2,533	2,477	164,600	139,400	107.0	83.0
66	2,438	2,470	160,000	139,600	103.0	83.5
67	2,306	2,349	154,800	147,100	97.0	84.5
68	2,339	2,297	156,400	142,600	99.0	81.0
69	2,339	2,306	153,100	138,700	96.0	80.0
70	2,388	2,379	164,200	146,400	86.0	78.5
71	2,500	2,500	168,100	153,800	87.0	73.0
72	2,615	2,608	167,500	151,800	83.0	71.0
73	2,756	2,740	168,300	148,800	84.0	69.5
74	2,831	2,831	169,500	151,800	83.0	68.0
75	2,936	2,920	168,900	147,600	82.0	66.0

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Comparison of cross-section elements, Fort St. Philip, La., to Head of Passes, La.—Cont'd.

SURVEYS OF 1893 AND 1903-4—Continued.

Number of section.	Width of cross section.		Area of cross section.		Maximum depth at low tide.	
	1893.	1903-4.	1893.	1903-4.	1893.	1903-4.
	Feet.	*Feet.*	*Sq. feet..*	*Sq. feet.*	*Feet.*	*Feet.*
76	3,061	3,012	162,900	144,600	80.0	64.0
77	3,068	3,068	164,100	139,100	77.0	61.0
78	3,117	3,068	161,700	144,900	73.0	61.5
79	3,100	3,117	169,700	142,100	82.0	78.5
80	3,127	3,136	171,600	151,700	98.0	79.0
81	3,127	3,136	167,200	148,000	88.0	78.0
82	3,215	3,150	165,500	163,200	73.0	82.5
83	3,182	3,232	179,500	157,600	111.0	84.5
84	3,176	3,264	175,700	158,100	123.0	82.5
85	3,264	3,255	173,900	149,200	102.0	87.0
86	3,353	3,287	171,500	156,500	108.0	83.0
87	3,412	3,386	177,500	158,100	99.0	82.0
88	3,484	3,419	184,200	168,400	95.0	82.0
89	3,609	3,530	167,000	160,200	82.0	81.0
90	3,609	3,642	178,100	162,700	92.0	77.5
91	3,625	3,701	177,500	158,300	92.0	72.5
92	3,707	3,747	179,400	156,700	86.0	67.0
93	3,789	3,789	182,100	157,400	79.0	64.0
94	3,845	3,789	182,000	156,000	76.0	64.0
95	3,806	3,789	180,200	159,700	78.0	63.5
96	3,845	3,845	183,600	159,500	68.0	60.0
97	3,898	3,845	182,200	153,100	66.0	58.5
98	3,871	3,881	181,600	158,500	63.0	57.0
99	3,937	3,924	179,800	152,500	64.0	54.0
100	4,127	4,019	168,000	155,300	50.0	55.0
101	4,183	4,068	157,000	158,000	50.0	56.0
102	4,216	4,117	163,100	157,500	70.0	54.0
103	4,085	4,094	144,300	152,000	57.0	48.5
104	4,144	4,045	142,300	140,800	54.0	46.5
105	4,144	4,085	149,500	135,000	62.0	44.0
106	4,239	4,173	158,400	144,600	64.0	45.0
107	4,416	4,252	161,500	143,200	64.0	44.5
108	4,396	4,331	162,600	145,500	55.0	45.0
109	4,534	4,413	159,700	144,300	51.0	49.0
110	4,633	4,521	165,600	153,500	53.0	49.5
111	4,797	4,665	166,600	156,400	45.0	50.5
112	4,964	4,889	174,800	163,400	46.0	47.5
113	5,194	5,030	168,300	157,600	44.0	46.0
114	5,358	5,194	177,000	163,300	44.0	43.5
115	5,453	5,367	175,100	160,200	43.0	40.5
116	5,659	5,551	172,300	166,800	42.0	40.5
117	5,784	5,702	175,300	173,100	41.0	38.0
118	6,122	5,978	178,100	172,200	40.0	37.5
119	6,358	6,217	180,100	178,200	39.0	39.0
120	6,670	6,585	176,200	178,200	37.0	38.0
121	7,021	6,890	188,800	184,200	37.0	37.0
Total	383,960	382,803	19,993,600	18,747,000	10,264.0	9,148.5
Average	3,173	3,164	165,236	154,933	84.8	75.6

APPENDIX C.

DETAILED INFORMATION RELATING TO LEVEE BUILDING.

[As furnished by the chief of engineers of the St. Francis levee district of Arkansas, the Yazoo-Mississippi Delta levee district, the Mississippi levee district, and the chief State engineer of Louisiana.]

REPLIES RECEIVED FROM THE CHIEF ENGINEERS OF THE ST. FRANCIS LEVEE DISTRICT OF ARKANSAS, THE YAZOO-MISSISSIPPI DELTA LEVEE DISTRICT, THE MISSISSIPPI LEVEE DISTRICT, AND THE CHIEF STATE ENGINEER OF LOUISIANA TO THE FOLLOWING LIST OF INQUIRIES REGARDING THE MEANS, WORK, ETC., OF THE SEVERAL LEVEE DISTRICTS.

1. Official or legal name of district.
2. Upper and lower limit of district fronting on the Mississippi River, and length of existing levee line on same; also length of levee lines, if any, on other streams.
3. Total valuation of property taxable or assessable for levee purposes.
4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions.
5. Amount of bonded debt, if any.

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6. Amount of other debts, if any, exclusive of amounts due or to become due for levee work under contract.
7. Rate and total annual amount of interest paid on bonded or other debt.
8. Amount paid by district for levee building or maintenance during past year (1904–5).
9. Estimated amount due or to become due by the district for levee work now under contract.
10. Amount paid during past year for right of way, legal or incidental expenses, and other costs of administration not included in (item 8) amount paid for levee building and maintenance.

FROM H. N. PHARR, CHIEF ENGINEER, ST. FRANCIS LEVEE DISTRICT OF ARKANSAS.

MEMPHIS, TENN., *April 24, 1905.*

Q. 1. Official or legal name of levee district?
A. 1. St. Francis levee district of Arkansas.
Q. 2. Upper and lower limit of district fronting on the Mississippi River, and length of existing levee line on same; also length of levee lines, if any, on other streams.
A. 2. Missouri State line and mouth of St. Francis River; 160 miles built; none.
Q. 3. Total valuation of property taxable or assessable for levee purposes.
A. 3. $20,000,000.
Q. 4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions.
A. 4. $122,935.44 for year ending May 1, 1904.
Q. 5. Amount of bonded debt, if any.
A. 5. $1,250,000; 6 per cent.
Q. 6. Amount of other debts, if any, exclusive of amounts due or to become due for levee work under contract.
A. 6. None.
Q. 7. Rate and total annual amount of interest paid on bonded or other debt.
A. 7. 6 per cent; $75,000.
Q. 8. Amount paid by district for levee building or maintenance during the past year (1904–5).
A. 8. $291,463.22, which includes $69,000 interest paid.
Q. 9. Estimated amount due or to become due by the district for levee work now under contract.
A. 9. $8,000.
Q. 10. Amount paid during past year for right of way, legal or incidental expenses, and other costs of administration not included in (Item 8) amount paid for levee building and maintenance.
A. 10. Everything included in Item 8. Itemized statement hereto attached.

Statement showing expenditures of St. Francis levee board of Arkansas for fiscal year beginning May 1, 1904.

Maintenance of levee	$4,248.14
Salary and per diem	6,385.00
Levee construction	166,265.68
General expense	3,089.21
Right of way and damages	15,387.53
Interest, discount, and commission	4,219.23
Drainage	166.29
Storage and supplies	269.27
Surveys	331.08
Costs	464.90
Levee lands	503.45
Engineer's office supplies	371.22
Salary assistant engineers and inspectors	7,467.57
Freight and transportation	392.65
High-water expenses	902.00
Interest on bonds and certificates	69,000.00
Total to March 1, 1905	279,463.22
Approximate estimate for March and April	12,000.00
Total	291,463.22

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Approximate estimate for March and April assumes no emergency expense, such as high water, but is based on normal conditions for running expense and bills now pending payment.

FROM T. G. DABNEY, CHIEF ENGINEER, YAZOO-MISSISSIPPI DELTA LEVEE DISTRICT.

CLARKSDALE, MISS., *April 27, 1905.*

STATEMENT.

1. Official or legal name of levee district.
A. Yazoo-Mississippi Delta levee district.
2. Upper and lower limit of district fronting on the Mississippi River, and length of existing levee line on same; also length of levee lines, if any, on other streams.
A. North boundary of the State of Mississippi for upper limit, and north boundary of Bolivar County, Miss., for lower limit. Present length of effective levee lines, 114 miles.
3. Total valuation of property taxable or assessable for levee purposes.
A. Assessed valuation of property as a basis of revenue, $26,942,368; also 2,682,935 acres of land.
4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions.
A. $425,866.44.
5. Amount of bonded debt, if any.
A. $1,654,000.
6. Amount of other debts, if any, exclusive of amounts due or to become due for levee work under contract.
A. None.
7. Rate and total annual amount of interest paid on bonded or other debt.
A. Six per cent on $825,000 equal $49,500; 4 per cent on $829,000 equal $33,160; total, $1,654,000, equal $82,660.
8. Amount paid by district for levee building or maintenance during past year (1904–5).
A. $398,427.70.
9. Estimated amount due or to become due by the district for levee work now under contract.
A. $143,496.46.
10. Amount paid during past year for right of way, legal or incidental expenses and other costs of administration not included in (Item 8) amount paid for levee building and maintenance.
A. $55,738.71.

FROM C. H. WEST, CHIEF ENGINEER, MISSISSIPPI LEVEE DISTRICT.

GREENVILLE, MISS., *May 1, 1905.*

In compliance with the request in letter of April 22, I have the honor to furnish the following information relative to this levee district:
1. Mississippi levee district.
2. Coahoma-Bolivar County line (365 L) to a point in Warren County, Miss., about seven miles back of Brunswick Landing (580 L); length of controlling levee, 189 miles.
3. Assessed valuation, exclusive of railroads, $14,334,226; assessed valuation of railroads, $3,737,042; total, $18,071,268.
NOTE.—The true valuation is estimated to be between $50,000,000 and $60,000,000.
4. $390,579.68 (collected twelve months ending April 30, 1905).
5. $2,150,000.
6. None.
7. 6 per cent on $700,000 and 5 per cent on $1,450,000 bonds, $114,500; on certificates of indebtedness and other items, $10,720; total, $125,220.
8. $766,879.97.
9. $38,148.
10. Rights of way, $147,645.14; collection of taxes, $9,686.25; guarding levee, $4,531.21; engineering, inspection, and expenses, $10,326.18; officers' salaries and general expenses, $15,739.05; total, $187,927.83.

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REMARKS.—During the year $1,000,000 received from the sale of $1,000,000 forty-year 5 per cent bonds. One hundred and fifty thousand dollars certificates of indebtedness, due and payable out of the revenues of 1904–5, paid. Rights of way unusually great on account of the Australia and other new levees. In addition to the above, $5,301.69 paid on Longwood revetment.

The foregoing data is made up for the twelve months ending April 30, 1905.

FROM F. M. KERR, CHIEF STATE ENGINEER, LOUISIANA.

STATE OF LOUISIANA,
OFFICE BOARD OF STATE ENGINEERS,
New Orleans, La., May 8, 1905.

STATEMENT.

Information in regard to the levee districts of the State of Louisiana, viz, official or legal name, location, valuation of property taxable or assessable, annual revenue for levee purposes, bonded debt, liabilities other than for levee work, rate and amount of interest paid, expenditure for levee building or maintenance season 1904–5, liabilities for levee work still under contract, amounts paid for right of way, cost of administration, etc.

[Prepared, by request, for the Mississippi River Commission.]

THE TENSAS BASIN LEVEE DISTRICT.

1. Official or legal name of district, "Tensas Basin levee district" (acts 59 of 1886 and 77 of 1888).

2. The Tensas Basin levee district comprises the parishes of Morehouse, West Carroll, Richland, Franklin, and Catahoula, with those portions of Ouachita and Caldwell parishes lying east of the Ouachita River, and therefore has no frontage on the Mississippi River. The district is more exposed to overflow by flood waters escaping from the Mississippi and Arkansas rivers in Arkansas than from any other source, and its work has always been mostly applied to the construction and improvement of levees in Desha and Chicot counties, Arkansas, as is contemplated in the act under which the district was organized.

3. The total valuation of property taxable or assessable for levee purposes (1904), $4,107,227.

4. Total revenue for levee purposes derived from taxes, assessments, or other forced contributions (1904), $20,536.17. (From this must be deducted delinquencies, costs of collection, legal and incidental expenses, etc.) In addition to the resources of the district, derived from local taxation, etc., a certain percentage of the general engineer fund (1 mill general State tax) is required by law to be annually set aside and expended in the interest of the district. In 1904 this amounted to $22,268.27.

5. Amount of bonded debt (authorized, $150,000) outstanding (April, 1905), $78,000.

6. Amount of other debts, exclusive of amounts due or to become due for levee work under contract (1904), none.

7. Rate of interest paid on bonded debt, 6 per cent; amount of interest paid on bonded debt (1904), $5,400.

8. Amount paid by district for levee building or maintenance during past year (1904–5), $29,465.91.

9. Estimated amount due or to become due by district for levee work now under contract (April, 1905), nothing.

10. Amount paid during past year for right of way, nothing; amount paid for legal or incidental expenses and other costs of administration, not included in (Item 8) amount paid for levee building and maintenance, $5,000.

THE FIFTH LOUISIANA LEVEE DISTRICT.

1. Official or legal name of district "The Fifth Louisiana levee district" (act 44 of 1886).

2. The upper and lower limits of the district, fronting on the Mississippi River, are respectively about opposite 520 and 764 miles below Cairo. The total frontage, however, at present, due to cut-offs, is only about 235 miles. The length of levee lines on same is 232.2 miles; the length of levee lines on other streams is 39 miles—that is, 12.7 miles on the Black River and 26.3 miles on the Tensas River.

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3. Total valuation of property taxable or assessable for levee purposes (1904), $6,962,290.

4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions (1904), $200,473.50.

5. Amount of bonded debt, $500,000.

6. Amount of other debts exclusive of amounts due or to become due for levee work under contract, $237,896.94.

7. Rate of interest paid on bonded debt, 5 per cent per annum; rate of interest paid on other debts, 6 per cent per annum; interest paid, $39,273.82.

8. Amount paid by district for levee building or maintenance during the past year, January 1, 1904, to April 26, 1905, $461,019.92. In addition to the foregoing, the State, during the same period, expended in levee building in the district, $144,763.39 out of the general engineer fund (1 mill State tax).

9. Estimated amount due or to become due by the district for levee work now under contract $60,722.54; by the State, $45,000.

10. Amount paid during past year for right of way, nothing—right of way exacted by law; amount paid during past year for legal and incidental expenses and other costs of administration not included in (Item 8), amount paid for levee building and maintenance, $10,480.

THE ATCHAFALAYA BASIN LEVEE DISTRICT.

1. Official or legal name of district, "Atchafalaya Basin levee district" (act 97 of 1890).

2. Upper and lower limits of district fronting on the Mississippi River, about opposite 757 and 886 miles below Cairo; length of existing levee line on Mississippi River, 128.1 miles; length of existing levee line on Atchafalaya River, 41.9 miles, and length of existing levee line on Bayou Lafourche, about 75 miles.

3. Total valuation of property taxable or assessable for levee purposes, $16,615,037.

4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions (1903–4), $264,151.42.

5. Amount of bonded debt (authorized $1,000,000) outstanding, $850,000.

6. Amount of other debts, exclusive of amounts due or to become due for levee work under contract (April, 1904), none.

7. Rate of interest paid on bonded debt, 5 per cent; amount of interest paid on bonded or other debt (1903–4), $46,562.05.

8. Amount paid by district for levee building or maintenance during past year (1903–4), $272,533.44. In addition to the foregoing the State, from January 1, 1904, to May 1, 1905, expended in levee building in the district $48,749.95 out of the general engineer fund (1 mill general State tax).

9. Estimated amount due or to become due by the district for levee work now (April, 1905) under contract, $60,000; by the State, $18,000.

10. Amount paid during past year (1903–4) for right of way, nothing—right of way exacted by law; amount paid during past year (1903–4) for legal or incidental expenses and other costs of administration, not included in (Item 8) amount paid for levee building and maintenance, $12,515.77.

THE CAT ISLAND LEVEE DISTRICT.

1. Official or legal name of district "Cat Island levee district" (act 110 of 1894).

2. Upper and lower limits of district fronting on Mississippi River, about 774.5 and about 799.5 miles below Cairo, respectively.

3–10. No action has ever been taken for raising funds or for undertaking levee work in this district.

THE PONTCHARTRAIN LEVEE DISTRICT.

1. Official or legal name of district "The Pontchartrain levee district" (act 95 of 1890).

2. Upper and lower limits of district fronting on the east or left bank of the Mississippi River, 835 and 957 miles, respectively, below Cairo; length of existing levee line on same, 125.6 miles; length of levee lines on other streams, none. An "upper protection levee" along the lower boundary limit of the city of Baton Rouge, and extending from the main line of levee on the Mississippi River back to the highlands, 1,526 feet in length, is, however, maintained by the district.

3. Total valuation of property taxable or assessable for levee purposes (1904), $7,496,370.

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4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions (1904), $110,169.49.

5. Amount of bonded debt (authorized $1,000,000) outstanding, $851,000.

6. Amount of other debts, exclusive of amounts due or to become due for levee work now under contract, nothing.

7. Rate of interest paid on bonded debt, 6 per cent; amount of interest paid on bonded or other debt, $51,920.

8. Amount paid by district for levee building or maintenance during past year (1903–4), $96,013.05.

In addition to the foregoing the State, from January 1, 1904, to May 1, 1905, expended in levee building in the district $22,998.75 out of the general engineer fund (1 mill general State tax).

9. Estimated amount due or to become due by the district for levee work now under contract (April, 1905), about $1,700.

10. Amount paid during past year for right of way, nothing—right of way exacted by law; amount paid during past year for legal or incidental expenses and other costs of administration not included in (Item 8) amount paid for levee building and maintenance, not available.

THE LAFOURCHE LEVEE DISTRICT.

1. Official or legal name of district "The Lafourche levee district" (acts 13 of 1892 and 59 of 1904).

2. Upper and lower limits of district fronting on the Mississippi River, 886 and 1,016.5 miles below Cairo; length of existing levee line on Mississippi River, 119.4 miles; length of existing levee line on Bayou Lafourche, 74.1 miles.

3. Total valuation of property taxable or assessable for levee purposes (1904), $11,423,739.

4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions (January 1, 1904, to January 1, 1905), $188,109.18.

5. Amount of bonded debt, $500,000.

6. Amount of other debts, exclusive of amounts due or to become due for levee work under contract, none.

7. Rate of interest paid on bonded debt, 5 per cent; amount of interest paid on bonded debt (1904), $25,000.

8. Amount paid by district for levee building or maintenance during past year (1904–5), $114,377.53.

In addition to the foregoing the State, during the same period, expended in levee building in the district, $48,279 out of the general engineer fund (1 mill general State tax).

9. Estimated amount due or to become due by the district for levee work now (April, 1905) under contract, nothing.

10. Amount paid during past year for right of way, nothing—right of way exacted by law; amount paid during past year for legal or incidental expenses and other costs of administration not included in (Item 8) amount paid for levee building and maintenance, $3,420.

THE ORLEANS LEVEE DISTRICT.

1. Official or legal name of district "The Orleans levee district" (act 95 of 1890).

2. The district lies partly on both sides of the Mississippi River, extending along the right bank from about 965.25 to about 979.35 miles below Cairo, and along the left bank from about 956.85 to about 969.50 miles below Cairo. The length of the existing levee line is 13.88 miles and 12.62 miles, respectively. The length of levee lines on other streams ("rear protection levees") is about 48 miles. Total length of levee line in district, about 74.5 miles.

3. Total valuation of property taxable or assessable for levee purposes (1904), $161,418,964.

4. Total annual revenue for levee purposes derived from taxes or assessments (1904), estimated at about $150,000; no forced contributions. In addition to the resources of the district, derived from local taxation, etc., $10,000 per annum is required by law to be transferred from the general engineer fund (one mill general State tax) to the credit of the district.

5. Amount of bonded debt (authorized $500,000) outstanding, $146,000.

6. Amount of other debts, exclusive of amounts due or to become due for levee work under contract (due banks at a rate of interest of 4½ per cent), $40,000.

7. Rate of interest paid on bonded debt, 5 per cent per annum; total amount of interest paid on bonded or other debt (1904), $12,681.

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8. Amount paid by district for levee building or maintenance during past year (1904–5), $184,782.47.
9. Estimated amount due or to become due for levee work now under contract (April, 1905), $20,000.
10. Amount paid during past year for right of way, incidental expenses, and other costs of administration, $47,358.

THE LAKE BORGNE BASIN LEVEE DISTRICT.

1. Official or legal name of district, "Lake Borgne Basin levee district" (act 14 of 1892).
2. Upper and lower limits of district fronting on the Mississippi River, 969.5 and about 1,016.5 miles below Cairo; length of existing levee line fronting on Mississippi River, 48 miles; length of levee lines on other streams, none.
3. Total valuation of property taxable or assessable for levee purposes (1904), $2,019,197.
4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions (1904), $28,565.
5. Amount of bonded debt, $100,000.
6. Amount of other debts, exclusive of amounts due or to become due for levee work under contract (April, 1905), none.
7. Rate of interest paid on bonded debt, 6 per cent per annum on $80,000 and 5 per cent per annum on $20,000; amount of interest paid on bonded or other debt (1904), $5,800.
8. Amount paid by levee district for levee building or maintenance during past year (1904–5), $17,400.47.
In addition to the foregoing the State, during the same period, expended in levee building in the district $16,931.27 out of the general engineer fund (1 mill general State tax).
9. Estimated amount due or to become due by the district for levee work now (April, 1905) under contract, $3,935.34.
10. Amount paid during past year for right of way, nothing—right of way exacted by law; amount paid for legal or incidental expenses and other costs of administration not included in amount paid for levee building and maintenance (Item 8), $4,355.62.

THE GRAND PRAIRIE LEVEE DISTRICT.

1. Official or legal name of district "Grand Prairie levee district" (acts 24 of 1898, 43 of 1900, and 16 of 1902).
2. Upper and lower limits of district fronting on Mississippi River, about 1,016.5 and 1,048.5 miles below Cairo; length of existing levee line on Mississippi River, 30.5 miles; length of levee lines on other streams, none.
3. Total valuation of property taxable or assessable for levee purposes (1904), $194,755.
4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions (1904), $6,097.
5. Amount of bonded debt, $30,000.
6. Amount of other debts, exclusive of amounts due or to become due for levee work under contract (April, 1905), none.
7. Rate of interest paid on bonded debt, 6 per cent. Amount of interest paid on bonded or other debt (1904), $1,800.
8. Amount paid by district for levee building or maintenance during past year (1904–5), $9,986.95.
In addition to the foregoing the State, during the same period, expended for levee building in the district $17,400.
9. Estimated amount due or to become due by the district for levee work now (April, 1905) under contract, nothing.
10. Amount paid during past year for right of way, nothing—right of way exacted by law; amount paid for legal or incidental expenses and other costs of administration, not included in amount paid for levee building and maintenance (Item 8), $2,062.42.

THE PLAQUEMINES PARISH EAST BANK LEVEE DISTRICT.

1. Official or legal name of district "Plaquemines Parish East Bank levee district" (acts 7 of 1902 and 11 of 1904).
2. The aims and purposes of this district are to raise funds for and to construct and maintain levees in said district along the coast of the Gulf of Mexico, for the purpose

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of protecting the lands thereof from overflow or inundation from the waters of the Gulf of Mexico, and therefore has no front on the Mississippi River. Length of proposed levee line fronting the Gulf of Mexico, about 33 miles.

3. Total valuation of property taxable or assessable for levee purposes (1904), $279,400.

4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions (1904), $9,009.95.

5. Amount of bonded debt, $135,000.

6. Amount of other debts, exclusive of amounts due or to become due for levee work under contract (April, 1905), none.

7. Rate of interest paid on bonded debt, 5 per cent; amount of interest paid on bonded or other debts (1904), $6,750.

8. Amount paid by district for levee building or maintenance during past year (1904–5), $28,899.70.

9. Estimated amount due or to become due by the district for levee work now under contract (April, 1905), $117,600.

10. Amount paid during past year for right of way, nothing—right of way exacted by law; amount paid for legal or incidental expenses and other costs of administration, not included in amount paid for levee building and maintenance (item 8), $1,233.99.

THE BURAS LEVEE DISTRICT.

1. Official or legal name of district "The Buras levee district" (act 18 of 1894).

2. Upper and lower limits of district fronting on the Mississippi River, about 1,016.5 and 1,049.5 miles below Cairo, respectively; length of existing levee line on Mississippi River, 33.7 miles; length of levee lines on other streams, none.

3. Total valuation of property taxable or assessable for levee purposes (1904), $490,018.

4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions (1904), $8,515.09.

5. Amount of bonded debt, $35,000.

6. Amount of other debts, exclusive of amounts due or to become due for levee work under contract, none.

7. Rate of interest paid by district on bonded debt, 6 per cent per annum; amount of interest paid on bonded or other debt (1904), $2,100.

8. Amount paid by district for levee building or maintenance during past year (1904–5), $14,262.44 (of which $10,754.42 was expended in revetment). In addition to the foregoing the State of Louisiana expended during the same period for levee building in the district, $14,050.96.

9. Estimated amount due or to become due by the district for levee work now (April, 1905) under contract, nothing.

10. Amount paid during the past year for right of way, nothing—right of way exacted by law; amount paid for legal or incidental expenses and other costs of administration, not included in amount paid for levee building and maintenance, not available.

THE CADDO LEVEE DISTRICT.

1. Official or legal name of district, "Caddo levee district of Louisiana" (act 74 of 1892 and act 160 of 1900).

2. The district fronts on Red River, the upper and lower limits being, respectively, about 118.75 and about 244 miles below Fulton, Ark.; the length of river front is at present about 106 miles; the district has an "upper" and a "lower" levee system, lying, respectively, above and below the highlands at Shreveport. The length of existing levee lines in the "upper levee system" is about 45 miles, and in the "lower levee system" about 35 miles; length of levee line on other streams, 9 miles (all on Bayou Pierre), not regarded as constituting part of main public system since the closure of Bayou Pierre and Tones Bayou, the latter formerly feeding same some 15 miles below its head.

3. Total valuation of property taxable or assessable for levee purposes (1904), $1,189,100.

4. Total revenue for levee purposes derived from taxes, assessment, or other forced contributions (1904), $30,000.

5. Amount of bonded debt, $300,000.

6. Amount of other debts, none.

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7. Rate of interest paid on bonded debt, 6 per cent per annum on $200,000 and 5 per cent per annum on $100,000; total amount of interest paid on bonded debt (1904), $17,000.

8. Amount paid by district for levee building or maintenance during past year (1904–5), $35,386.55.

In addition to the foregoing, the State, during the same period, expended in levee building in the district $22,226.77 out of the general engineer fund (1 mill general State tax).

9. Estimated amount due or to become due by the district for levee work now under contract (April, 1905), about $4,500; by the State, $7,500.

10. Amount paid during the past year for right of way, nothing—right of way exacted by law; legal or incidental expenses and other costs of administration not included in (item 8) amount paid for levee building and maintenance, not available.

THE BOSSIER LEVEE DISTRICT.

1. Official or legal name of district, "The Bossier levee district of Louisiana" (act 89 of 1892).

2. The Bossier levee district fronts on Red River, and its upper and lower limits on said stream are, respectively, 162 and 242.75 miles below Fulton, Ark. (United States charts of Red River); length of existing levee line on Red River, 57.1 miles; length of levee lines on other streams, none.

3. Total valuation of property taxable or assessable for levee purposes (1904), $1,507,124.

4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions (1904), about $28,000.

5. Amount of bonded debt, authorized, $300,000; outstanding, $250,000.

6. Amount of other debts, exclusive of amounts due or to become due for levee work under contract (April, 1905), none.

7. Rate of interest paid on bonded debt, 6 per cent per annum on $200,000 and 5 per cent per annum on $50,000; amount of interest paid on bonded or other debt, about $12,500.

8. Amount paid by district for levee building or maintenance during past year (1904–5), about $30,000.

In addition to the foregoing, the State, during the same period, expended for levee building in the district $24,540.96 out of the general engineer fund (1 mill general State tax),

9. Estimated amount due or to become due by the district for levee work now under contract (April, 1905), nothing; by the State, $8,500.

10. Amount paid during past year for right of way, nothing—right of way exacted by law; amount paid for legal or incidental expenses and other costs of administration not included in amount paid for levee building and maintenance (item 8), not available.

THE RED RIVER, ATCHAFALAYA, AND BAYOU BOEUF LEVEE DISTRICT.

1. Official or legal name of district, "The Red River, Atchafalaya, and Bayou Boeuf levee district" (acts 79 of 1890 and 46 of 1892).

2. The district lies partly on both sides of Red River and on the west side of the Atchafalaya River. It is further affected by floods backing up several interior streams, principally Bayou Rapides, Bayou des Glaizes, and Bayou Courtableau. Natural features necessarily divide the district into an "upper" and a "lower" levee system. The line of public levee in the upper levee system extends continuously from the highlands on the south bank of Bayou Rapides, about 1.5 miles above the mouth of the bayou, down the bayou to its junction with Red River at Alexandria about 1.5 miles; thence down the west or right bank of Red River to the Avoyelles Prairies at Davids Ferry, about 35.5 miles in length. The line of public levee in the "lower levee system" extends continuously along the right bank of Bayou des Glaizes from the "junction," about 9 miles above Moreauville, down the bayou to its junction with the Atchafalaya River at Simmsport, about 48 miles, and thence along the west or right bank of the Atchafalaya River to a point about 6 miles below Melville, a length of about 32 miles.

3. Total valuation of property taxable or assessable for levee purposes (1904), $4,573,175.

4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions (1904), $60,000.

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5. Amount of bonded debt, $500,000.
6. Amount of other debts, exclusive of amounts due or to become due for levee work under contract, none.
7. Rate of interest on bonded debt, 5 per cent per annum; total amount of interest paid on bonded or other debts (1904), $25,000.
8. Amount paid by district for levee building or maintenance during past year, $134,563.55.
In addition to the foregoing, the State, during the same period, expended in levee building in the district $24,677.50 out of the general engineer fund (1 mill general State tax).
9. Estimated amount due or to become due by the district for levee work now under contract, $60,000; by the State, $8,000.
10. Amount paid during past year for right of way, nothing—right of way exacted by law; amount paid for legal or incidental expenses and other costs of administration not included in amount paid for levee building and maintenance, $3,500.

THE RED RIVER AND BAYOU DES GLAIZES LEVEE AND DRAINAGE DISTRICT.

1. Official or legal name of district "Red River and Bayou des Glaizes levee and drainage district" (act 109 of 1904).
2. The Red River and Bayou des Glaizes levee and drainage district fronts on Red River and the Atchafalaya River. Operations have only commenced this season, and therefore no completed line of levee yet exists. The length of the proposed line of levee may ultimately be about as follows: On Red River, about 70 miles; on the Atchafalaya River, about 5 miles, and on Bayou des Glaizes, about 50 miles.
3. Total valuation of property taxable or assessable for levee purposes (1904), $247,665.
4. Total annual revenue for levee purposes derived from taxes, assessments, or other forced contributions (1904), about $20,000.
5. Amount of bonded debt, $300,000.
6. Amount of other debts, exclusive of amounts due or to become due for levee work now under contract (April, 1905), none.
7. Rate of interest paid on bonded debt, 5 per cent per annum; amount of interest paid on bonded or other debt (1904), none yet due.
8. Amount paid by district for levee building or maintenance during past year (1904–5), nothing yet earned.
9. Estimated amount due or to become due by the district for levee work now (April, 1905) under contract, $300,000.
10. Amount paid during past year for right of way, nothing—right of way exacted by law; amount paid for legal or incidental expenses and other costs of administration, not included in amount paid for levee building and maintenance (item 8), not available.

THE COURTABLEAU LEVEE DISTRICT.

1. Official or legal name of district "The Courtableau levee district" (act 166 of 1902).
2. The Courtableau levee district fronts on Bayou Courtableau and the Atchafalaya River.
3–10. No action has yet been taken by this district to raise funds, nor to undertake any levee work.

THE MERMENTAU LEVEE DISTRICT.

1. Official or legal name of district "Mermentau levee district" (act 79 of 1904).
2. The aim and purpose of the Mermentau levee district is to raise funds for and to undertake work to protect the lands of the district "from overflow or inflow of fresh or salt water." No action has yet been taken by the district to further its objects.

The foregoing statement has been compiled partly from the records of the board of State Engineers, and of the auditor of public accounts of the State of Louisiana, and from statements requested from and furnished by the levee districts.

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APPENDIX 1.

REPORT OF CAPT. WM. B. LADUE, CORPS OF ENGINEERS, SECRETARY MISSISSIPPI RIVER COMMISSION.

MISSISSIPPI RIVER COMMISSION,
OFFICE OF THE SECRETARY,
St. Louis, Mo., May 31, 1905.

COLONEL: I have the honor to submit the following report of operations under this office for the year ending May 31, 1905:

The work in charge of the secretary of the Mississippi River Commission is carried on under allotments made by the Commission from appropriations for improving the Mississippi River between the Head of the Passes and the mouth of the Ohio River, under allotment for fiscal year from permanent appropriation provided by section 9 of the river and harbor act of June 13, 1902, for gauging the waters of the Mississippi River and its tributaries; and under appropriation in river and harbor act of June 13, 1902, for surveys and examinations from mouth of Illinois River to St. Louis to determine the feasibility of navigable waterway 14 feet in depth.

The allotments from the first-named appropriation are as follows:

(*1*) *Mississippi River Commission.*—Available for salaries, clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission.

(*2*) *Surveys, gauges, and observations.*—Available for survey of the Mississippi River between the Head of the Passes and its headwaters, for the establishment and maintenance of gauges, for special surveys and examinations, and for the collection and reduction of physical data pertaining to the Mississippi River.

(*3*) *Dredges and dredging.*—Available for the construction, operation, and maintenance of dredging plant for the Mississippi River from Head of the Passes to the mouth of the Ohio River.

The allotment from the permanent appropriation for gauging is available for paying gauge observers and other expenses incident to maintaining gauges at specified places on the Mississippi River and its tributaries.

The appropriation for survey from mouth of Illinois River to St. Louis in connection with deep waterway survey from Lockport, Ill., to St. Louis, Mo., is available for surveys, borings, discharge measurements, and reduction and platting of same.

MISSISSIPPI RIVER COMMISSION.

The Mississippi River Commission held three sessions during the year, as follows:

Ninety-second session, June 27–29, 1904, at St. Louis, Mo.

Ninety-third and ninety-fourth sessions on board the U. S. S. *Mississippi*, St. Louis, Mo., to New Orleans, La., November 10–19, 1904, and April 5–13, 1905, respectively.

Plant and outfit.—The steamer *Mississippi* has been in service with the Commission on its inspection trips, and during the balance of the time has been laid up at West Memphis, Ark., where various minor repairs have been made.

SURVEYS, GAUGES, AND OBSERVATIONS.

Survey of the Mississippi River.—This survey, which is authorized by the law creating the Mississippi River Commission, to extend from Head of the Passes to the headwaters of the river, has been made with the view of obtaining accurate data for topographical and hydrographical maps for use in study of the river in connection with planning improvements. The most approved methods have mainly been used in this work.

The field work comprises secondary triangulation, precise levels, topography, and hydrography. The instructions to field parties for this work will be found in the report of the Chief of Engineers for 1891, pages 3474–3485; the instructions for precise leveling, as revised, will be found in the Report of the Chief of Engineers for 1899, pages 3469–3474.

A summary of the surveys to 1896 is printed in the Report of the Chief of Engineers for 1896, pages 3574–3576; the progress of the work since will be found in succeeding annual reports. The condition of the work at the beginning of the present fiscal year will be found in the Supplement to the Report of the Chief of Engineers for 1904, page 43.

The secondary triangulation now covers the entire river from Head of the Passes to the headwaters at Lake Itasca (1,275 miles above Cairo), a distance by river of

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about 2,347 miles. The triangulation follows the river to Aitkin, Minn. (1,086 [a]). From Brainerd, Minn., about 55 miles below Aitkin, it is carried directly across country to Lake Itasca and thence down the river to Lake Bemidji. From Lake Bemidji a base line whose length and azimuth are accurately determined has been carried along the railroad to Grand Rapids, thence down the State road to Aitkin, thus forming a loop. This base line forms the basis of the topography and hydrography which have been completed from the mouth of the river to its headwaters, including the Itasca State Park. The precise levels also cover the entire river and generally follow the same lines as the triangulation, but extend down to the end of the jetties at the mouth of South Pass.

The lines of precise levels on the lower river were rerun in 1899 as far north as Fort Adams, Miss., and an account of the results is printed in the Report of the Chief of Engineers for 1900, page 4559. The extension of this releveling northward until the disappearance of the discrepancy found to exist between the earlier and later lines is contemplated.

Low-water survey, Cairo to mouth Arkansas River.—This survey was undertaken in compliance with resolution of the Mississippi River Commission, June 26, 1902, to determine the present shore line and to furnish other data for a new edition of inch-to-mile maps for this stretch of the river, the first edition made from surveys of twenty years ago having been in part exhausted. The field work of this survey was carried in 1902 from Cairo, Ill., to Corona Landing, Mo. (203), and was completed in 1904 to Arkansas River (402). The field notes are now being reduced and platted.

WORK DONE DURING THE YEAR.

General survey.—At the time of my last annual report a party, under charge of Assistant Engineer W. G. Comber, was in the field extending the topography and hydrography from Pokegama dam, where the field work of 1903 was closed, toward a junction with the field work of 1900, which extended about 25 miles down the river from Itasca Park. The field work was completed about July 20, and about 3½ miles of shore line in the vicinity of the park, omitted in 1900 on account of high water, was also filled in. The party was then disbanded and the outfit shipped to St. Louis and Memphis. The character of the survey work in Minnesota has been fully described in previous annual reports (1900, p. 4558; 1901, p. 42; 1902, p. 33; 1903, p. 61; 1904, p. 43). The field cost of the work of 1904 was $19,325.14. The party was in the field seven months, and carried ordinary levels, topography, shore line, and soundings over about 150 miles of river and several large lakes. Owing to the employment of the force upon other work since their return from the field, the work of reducing the notes has not yet begun.

Low-water survey, Cairo to mouth Arkansas River.—The river having fallen to a suitable stage, two parties were put in the field early in September. One party, under Assistant Engineer W. G. Comber, with the small steamer *Mars* and the quarter boat *Illinois*, began work September 1, at Corona Landing, Tenn. (203), and joined the work of the second party 2 miles above the mouth of the St. Francis River (298) on October 27. The second party, under Assistant Engineer A. T. Morrow, with the steamer *Patrol*, began work September 12, about 2 miles above the mouth of the St. Francis River, and completed its work one-quarter mile below the mouth of the Arkansas River, November 7. The methods followed in the field work were essentially as described in the Annual Report for 1903, pages 61 and 97, except that, owing to the difficulty of finding a sufficient number of the old permanent marks, Mr. Morrow's party carried a system of tertiary triangulation over the portion of the river covered by it. The total field cost of the work of both parties for the season was $11,074.91. About 200 miles of river were covered, making the average cost per mile $55.37. The reduction of the field notes of the work is now in progress.

Hydrographic resurvey from Forts Jackson and St. Philip to Head of Passes.—The field work of this survey was completed January 18, 1904, as stated in my last annual report (1904, p. 43). After the notes had been reduced and platted a careful comparison between the results of this survey and those of the surveys of 1893 and 1883 was made by Mr. Morrow. This comparison seems to show a slight but general decrease in maximum depth over the greater part of this stretch. The data have been forwarded to the Coast and Geodetic Survey member of the Commission for further study.

Survey of the Atchafalaya River from Barbre Landing to the junction of the Little Atchafalaya and upper Grand rivers.—This survey was ordered by the Commission at its ninety-third session, November 18, 1904. The field party, under Assistant Engi-

[a] Miles above Cairo.

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neer W. G. Comber, on the steamer *Patrol*, left West Memphis December 3 and began work at Barbre Landing December 9. The survey comprised a duplicated steel tape and azimuth line over the entire stretch, checked by frequent observations on Polaris, a duplicated line of precise levels, ordinary levels, slope, hydrography, and topography on each bank as far back as the controlling levee lines and generally beyond them. Discharge measurements were also made at Neita, La., at a stage of 3.4 to 5.7 on the Melville Weather Bureau gauge, using rod floats and double floats. The work was completed January 28 and the party disbanded, the tape-line party being retained to make tape and azimuth connection between Barbre Landing and the system of permanent marks on the main river. This work was done January 31 and February 1, and the party returned to West Memphis, arriving there February 27, after experiencing much delay because of heavy floating ice. Upon the return of the members of the permanent force to the office the reduction of the notes was at once begun and is still in progress.

The total cost of the field work was $9,604.12. The distance covered was 69 miles, making the average cost per mile $139.19. The long distance from Memphis and St. Louis to the field and the delays experienced on the return trip were prominent factors in the cost.

For further details as to methods and results attention is invited to the report of Mr. W. G. Comber, Appendix 1 B.

Plant and outfit.—The floating plant now consists practically of the steamer *Patrol* and quarter boat *Illinois*, with some small boats and skiffs. This plant, when not in field service, has been cared for at West Memphis. In June, 1904, the *Patrol* was sent to Paducah, Ky., where extensive repairs to her hull were made and a new wheel built, under emergency contract with Mr. Ed. J. Howard, of Jeffersonville, Ind., at a total cost of $8,485.50. While she was on the ways new steel cylinder beams were installed, and minor repairs made by hired labor. The boat was launched September 1, and returned under her own steam to West Memphis, where she went at once into service with the low-water survey.

Reduction and platting of field notes.—Upon the reduction of the field notes of the base line and precise levels between Aitkin and Grand Rapids, season of 1902, the loop formed by the lines from Brainerd to Itasca, thence to Bemidji, thence to Grand Rapids, thence to Aitkin and Brainerd, was adjusted. The geodetic positions of points between Bemidji and Grand Rapids, as published in the report for 1901, pages 65 and 66 (Table No. 3), require some correction on account of their adjustment. The corrected values are given in Table No. 1, and the positions of a few points in the vicinity of Aitkin, not previously published, are given in Table No. 2. The elevations of precise bench marks north of Brainerd, as published in the report for 1901, pages 72 to 111 (Tables Nos. 5 and 6), and report for 1899, pages 3456–3468 (Table No. 5), also require correction in consequence of the adjustment of the precise level loop. The corrected elevations above Cairo datum are given in Table No. 3.

For a discussion of the adjustment of the precise level loop attention is invited to the report of Junior Engineer E. L. Harman, Appendix 1 C.

The platting of the field notes of the topography and hydrography of the season of 1903, between Aitkin, Minn., and Pokegama dam, was continued as other and more pressing work permitted. About 18 miles of this work yet remain to be platted.

The platting of the field notes of the low-water survey from Cairo to Corona Landing, season of 1902, was completed.

Progress has been made in the reduction of the field notes of the low-water survey, season of 1904, and the Atchafalaya River survey.

Mapping.—Detail charts Nos. 225 to 232, inclusive, above Minneapolis, Minn., scale 1:5,000, were completed. Progress was made on charts Nos. 233 to 238 of the same series. Chart No. 238 extends this series to about 50 miles above Aitkin, Minn.

Map No. 136, inch-to-the-mile series, was completed and progress made on Nos. 137 to 141. Map No. 141 extends the series to about 34 miles above Little Falls, Minn.

Published maps and charts.—Detail charts Nos. 219 to 225, inclusive, were published to a scale of 1:10,000. This extends this series from Minneapolis, Minn., to about 1½ miles below Brainerd, Minn. (1,039[a]).

Map 136, inch-to-the-mile series, was published, extending the series to the upper limits of the city of Minneapolis, Minn. (894[a]).

The cost of these publications was $981.27.

A list of the maps and charts published by the Commission, together with the regulations relative to their free issue to certain persons, may be found on page 35 of the Supplement to the Annual Report of the Chief of Engineers for 1902.

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[a] Miles above Cairo.

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Gauges.—The permanent gauges, the high-water gauges, and the tide gauges have been maintained during the year. The permanent gauges have been twice inspected during the year, as prescribed by the Commission, gauges and bulletins being repaired and left in good order. Special inspections were made of gauges at St. Louis, Cape Girardeau, Cairo, Cottonwood Point (122), and Mhoon Landing (276).

There are are 38 permanent gauges, comprising 17 established by the Commission and 21 received by transfer from the United States Engineer Office at Vicksburg in 1901. They are distributed as follows: 25 on the Mississippi River from St. Louis, Mo., to Fort Jackson, La.; 1 on Atchafalaya River; 1 each on Arkansas, Cumberland, Tennessee, and St. Francis rivers; 3 on the Red River; 3 (including Cairo) on the Ohio River; 2 on the White River. The gauge on the Atchafalaya at Barbre Landing, La., is under charge of the fourth district officer. The gauges established by the Mississippi River Commission are maintained by allotments from the appropriation for "Improving Mississippi River from Head of Passes to the Mouth of the Ohio River;" the others, by allotments from the permanent appropriation for "Gauging the Waters of the Mississippi River and its Principal Tributaries," established by acts of August 11, 1888, and June 13, 1902. A description of these gauges is printed in Supplement to Report of the Chief of Engineers for 1902, pages 52 to 59.

The highest and lowest readings on the permanent gauges during 1904 are given in Table No. 4, with the previous highest and lowest for comparison. The highest and lowest readings for each year since 1898, and for earlier years in cases of stations not heretofore published, are given in Table No. 5. A hydrograph, showing the daily stages of the main river from Cairo to Fort Jackson from June 1, 1904, to May 31, 1905, is given on plate 1.

During the year new inclined gauges of timber with iron strip for graduations were constructed at Cape Girardeau, Mo., and Nashville, Tenn., and the gauge at Memphis was extended to the 2-foot mark. The graduations and figures were marked in the steel of the Cairo and Memphis gauges. The gauge at Cairo was protected by riprap where threatened by scour.

New bulletins were erected at New Madrid, Mo., Cottonwood Point, Mo., Fulton, Tenn., mouth of White River, Ark., Lake Providence, La., Natchez, Miss., and Carrollton, La.

The gauge at Aitkin, Minn., maintained by the Commission in connection with the survey of the upper Mississippi, was discontinued June 30, 1904.

High-water gauges.—The high-water gauges are 185 in number, distributed on the Mississippi River from Cairo to the Head of the Passes, about 5 miles apart. These gauges are read at times of highest water only, and supplement the regular gauges in determining the high-water slope of the river. They were inspected and put in order previous to the high water this spring, but as only a very moderate stage was reached no readings on these gauges were taken.

Tide gauges.—The tide gauges at Biloxi, Miss., and East Bay, La., have been maintained in good order and continuous records for the year secured. The gauge house and walk at East Bay were rebuilt during the year, and the staff gauges at both stations were connected with their bench marks by precise levels in February, 1905. The precise-level party also reran the line from Head of the Passes to Port Eads.

Discharge observations.—The resolution of the Mississippi River Commission governing the measurement of the high and low water discharges of the Mississippi River and its tributaries may be found on page 36 of the Supplement to Report of the Chief of Engineers for 1902.

During June, 1904, the prescribed stage for discharge measurements on the Arkansas River was reached at Little Rock, Ark., and an excellent series of measurements was made by a party under charge of Mr. E. E. Whitehead, using a chartered steamer. Thirteen sets of discharges were secured, covering the highest stage reached, 29.4 feet. The discharge stage at this point was again reached in July, 1904, and ten discharges, covering the highest stage, 26.5 feet, were measured by a party under charge of Junior Engineer E. L. Harman, a chartered steamer being again used.

In December the prescribed stage for low-water discharge measurements was reached at Columbus, Ky., and at Carrollton, La. Eleven sets of discharge measurements were made at Carrollton, by a party under Junior Engineer Geo. H. Wolbrecht, on the steamer *Mars*. At Columbus the discharge stage lasted but three days, December 24 to 26, and the party which was sent to that point, having been delayed by stormy weather and high winds, failed to arrive until after the river had risen several feet. The observations were therefore not made.

The discharge of the Atchafalaya River was measured in December near Neita, La., in connection with the survey of the Atchafalaya River.

All meters were carefully rated in the settling basin of the St. Louis waterworks during the summer of 1904. Each meter was again rated after being used for discharge work.

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The results of all discharge measurements and meter ratings made during the year are published in Tables Nos. 6 and 7.

For additional details of gauge inspections and discharge work, attention is invited to report of Assistant Engineer Kivas Tully, Appendix 1 D.

DREDGES AND DREDGING.

Project.—On the 20th of June, 1896, the Mississippi River Commission adopted a project for obtaining and maintaining, by means of dredges, a channel in the Mississippi River below Cairo, with a width of 250 feet and a depth of at least 9 feet throughout the year, except when the river is closed by ice. This project provided for the construction and operation of seven hydraulic dredges by the 30th of June, 1900, and for the provisional construction of two others if found necessary.

The building of this plant has formed a very important part of the work of this office, and has involved the preparation of plans and specifications for the dredges themselves, for the necessary large and small tenders, pile sinkers, and other plant. Since the beginning of the construction of this dredging plant many changes have taken place in the method pursued to procure the most efficient and best designed dredges.

The first dredge was built after plans prepared by the dredging committee, and was in the nature of an experiment. While many changes in this boat were afterwards found necessary, it yet demonstrated beyond a doubt the efficiency of such hydraulic dredges for the purpose for which it was designed.

The next step was to define, in general terms, the conditions which the dredges must fulfill, leaving to the builders the details of the design. Following this course three dredges were built. Experience was constantly gained until a point was reached where it was possible to outline, with greater accuracy, nearly all the details of construction. Under such specifications two more dredges were built. Under still more rigidly drawn specifications, another, the seventh, a self-propelling dredge, was placed under contract in 1898. This dredge was completed and delivered to the United States in August, 1900. The eighth and ninth dredges, also self-propelling, were placed under contract in June, 1899, and were completed and delivered to the United States in July, 1901. In June, 1902, the *Alpha* having become unserviceable, the construction of a tenth dredge, to be self-propelling, was decided upon. Specifications for this dredge, which will embody all features that experience has shown to be desirable, were published in Appendix 1 E to my last annual report. Bids for its construction were opened June 25, 1904, but all bids were rejected and the work readvertised. Bids were again opened July 25, and again all bids were rejected. Some changes in the specifications having been made, to provide for certain improvements in design, the work was advertised the third time. Bids were opened March 17, 1905, and award was made to the Springfield Boiler and Manufacturing Company for the dredge and pipe line, complete. Contract was entered into under date of April 21, and the contractors have begun the work of assembling the necessary materials.

CONSTRUCTION, ALTERATION, AND REPAIRS TO PLANT.

During the year the usual large amount of repair work has been required to keep the fleet in condition for service, and to repair the wear due to the season's use. Various alterations shown by experience to be desirable have also been made. Some of the more important of these repairs and alterations are mentioned in the following paragraphs.

The after main decks of the dredges *Gamma*, *Delta*, *Epsilon*, and *Zeta* were extended about 10 feet by an overhang at the stern, thus affording a considerable space in rear of the deck house for the installation of the blacksmith shop and forge. This enables these dredges to dispense with the plunder barge which formerly carried the blacksmith shop and was an essential part of each nonpropelling dredge unit. The gain in handiness and convenience is considerable. The work of shrouding the runner of the main pump of the *Zeta*, which was in progress at the date of my last annual report, was completed, and the same work is now under way on the *Delta*. All the main-pump runners are now, or soon will be, of the shrouded type, except those of the *Beta* and the *Gamma*, and it is proposed to alter the runners of the *Beta* to this type next season. Experience has shown the shrouded runner to possess marked advantages over the open runner. Not only is the efficiency somewhat higher when both types are in equally good condition, but, what is even more important, the efficiency is maintained much better in the shrouded type, as the clearance does not increase so rapidly with use, the wear on the runner and pump

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casing is less, and can be more easily taken up. A new runner has been purchased for the *Iota*, to replace the one worn-out during the past season by dredging in the hard gravel at Presidents Island. The *Zeta's* runner also suffered severely from the same cause, but it is expected to last another year.

Examination of limited areas of the skin plating of the dredges and tenders below the water line having shown the presence of considerable pitting and corrosion, it was deemed best to dock one or more units of the plant for a complete examination, cleaning, and repainting of the hulls. The engineer officer at Louisville, Ky., having authorized the use of the docks at the locks of the Louisville and Portland Canal for this purpose, the dredge *Delta* and tender *Sachem* were sent to that point in June, 1904. Both boats were found to be badly pitted below the water line, the pitting being general and quite uniform on sides and bottom. The deeper pits were from three thirty-seconds to one-eighth inch deep. Both hulls were sand blasted and painted two coats of good red lead and oil. The condition of the hulls of the *Delta* and the *Sachem* having shown the necessity of checking corrosion of the hull plating of the boats, the dredge *Gama* and tender *Wynoka* were sent to Louisville in July for the same treatment. They were found to be in about the same condition as the *Delta* and *Sachem*. The dredge *Epsilon* and tender *Nokomis* were sent to Louisville about the end of April, 1905, for similar treatment, but coal tar, applied hot, will be used instead of red lead. The experience of this office is that red lead does not form a durable protective coating on steel hulls in the Mississippi River, while coal tar seems to give much better satisfaction for the purpose. The experience of the fourth district office is understood to be similar. The pitting of these boats has raised the question of the relative durability of steel and iron for hull plating, and iron has been prescribed for the new dredge *B. M. Harrod*, in the belief that pitting will be less. The pontons of the fleet were also found to be in bad condition from the same cause. By the use of the new sectional docks, those of the *Iota*, *Kappa*, *Henry Flad*, *Epsilon*, and half of the *Zeta's* have been taken out, sand blasted, and painted with coal tar, and the remainder will receive similar treatment at an early date.

The suction head of the dredge *Beta*, which was lengthened in 1904 to adapt the boat to service in South Pass, has been shortened to a length suitable for dredging to a depth of 20 feet. The question as to the appropriation chargeable with the expenses of this work having been submitted to the Comptroller, decision was rendered that payment should be made from the appropriation for "Maintenance of South Pass Channel, Mississippi River," 1904 (E. D. file No. 28955/216).

The suction and discharge pipes in the holds of the various dredges are beginning to show considerable wear. During the season holes appeared in the suction pipe of the *Delta*, and the discharge pipe of the *Iota*. These, as well as other weak places, have been patched, and the discharge pipe of the *Iota* has been turned over to bring a comparatively unworn surface to the bottom, where the greater wear occurs. The other dredges needed no repairs of this nature this year.

The feed-water heater removed last year from the *Wynoka* has been installed on the dredge *Gamma*. A gain in economy of operation is expected to result. The feed-water heaters of the *Epsilon* and *Zeta* are to be replaced with new ones of better design, and it is proposed to install jet condensers at the same time, these two dredges being the only ones not equipped with condensers. The gain in economy to be expected from the new installation was pointed out by Assistant Engineer F. B. Maltby in his report on Tests of Dredges, printed as Appendix 1 F to my report for 1903. (Report of Chief of Engineers, 1903, p. 139).

The hull of the steamer *Minnetonka* was rebuilt during the summer of 1904, at Paducah, Ky., under contract with Mr. Ed. J. Howard, at a total cost of $16,593.68. Other repairs were made at the same time by hired labor. The steamer was launched August 29, 1904, and returned to West Memphis under her own steam.

The new machine and blacksmith shop was put in operation during the year. It now contains a 30-inch lathe, a 5-foot radial drill, a 36-by-30 inch planer, a combined punch and shears of sufficient power to punch a five-eighths-inch hole in five-eighths-inch iron plate, a 6-inch duplex pipe-cutting machine, two small lathes, a 500-pound steam hammer, two forges, and a crane for handling heavy work. The carpenter shop is equipped with a band saw and a small wood lathe. All the tools are run by shafting from an engine located in the machine shop. The entire plant has proven very successful, enabling a large amount and variety of work to be done more quickly, more conveniently, and more cheaply than before its installation. Two barges and six sectional docks have been built. The barges take the place of old ones worn out and condemned. The sectional docks have proven extremely useful in taking out pontons, pile sinkers, the small tenders, and the quarter boat *Illinois*, for repairs and painting. They are of sufficient size to take out the *Search* or the *Patrol*, if necessary.

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For additional details of repairs during the year, attention is invited to report of Assistant Engineer Wm. Gerig, Appendix 1 E.

DREDGING OPERATIONS ON THE LOWER MISSISSIPPI RIVER BETWEEN CAIRO, ILL., AND HEAD OF THE PASSES.

A statement of the general principles which have governed the conduct of dredging operations may be found in the Report of the Chief of Engineers, U. S. Army, for 1898, pages 3166–3169, and in the Report of the Chief of Engineers, U. S. Army, for 1900, page 4564.

During the low-water season of 1904 seven dredges, the *Beta*, the *Delta*, the *Epsilon*, the *Zeta*, the *Iota*, the *Kappa*, and the *Henry Flad*, were in commission. The *Gamma* was sent to Louisville, Ky., in July to be docked, cleaned, and painted. She was caught by low water in the Ohio and was detained at Louisville until the end of December, and was therefore not available during the dredging season. The *Beta*, though in commission from about September 28 to October 12, was not sent into the field, so that only six dredges were actually operated during the season.

The dredges were assigned to different stretches of the river. Three survey parties were kept in the field, and surveys were made of all bars where trouble was anticipated. Frequent surveys were made of those bars where dredging was done, to observe the effect of the dredging. These surveys served to determine the areas of shoal water and to enable the location of the channels to be intelligently made. Frequent inspections were made of that part of the river where shoals are known to exist, and all crossings sounded. The greatest possible publicity was given to information obtained, and all channels were located by easily distinguishable marks.

The river conditions during the low-water season are shown on the annual hydrograph, plate 1. The limits of the principal fluctuations at Cairo and Memphis between August 1 and December 31 are given in the following table:

CAIRO.

Date.	Reading.	Date.	Reading.
August 1	16.5	October 24	6.83
August 18	10.8	November 4	9.46
August 26	13.75	December 25	3.1
September 19	7.35	December 31	13.15
October 3	12.87		

MEMPHIS.

August 1	12.5	October 27	3.0
August 20	6.1	November 7	5.0
August 28	8.0	December 25	.65
September 21	3.85	December 31	8.75
October 6	7.2		

As compared with the seasons of 1902 and 1903, medium low stages this year were recorded earlier, and lasted much longer. The river was below a 10-foot stage at Cairo from September 3 to 21, and from October 9 to December 30, and below a 15-foot stage from August 3 to January 15. In 1902 stages of 10 feet or less prevailed only from September 19 to 28 and on November 7, 8, and 9, and the river was above 15 feet except from September 12 to October 2, and from October 31 to November 28, while in 1903 a stage of 10 feet or less lasted only from December 5 to 26, 15 feet being first reached on November 4. In 1901, however, the stages were lower than in 1904 from the end of September to December 7, falling below 10 feet from October 2 to December 14. Stages of 5 feet or less were recorded from October 28 to December 7 in 1901, from December 16 to 22 in 1903, from December 19 to 28 in 1904, and not at all in 1902. The number of hours of actual dredging, however, was twice that for 1903, and 30 per cent greater than in any previous year in the history of the plant, being 4,278 hours, the maximum previously recorded being 3,259 hours in 1899.

Dredging was required this season at seventeen localities between Nolans (76) and Andersons (359). As the river fell, in the latter part of August, the six available dredges were made ready for the field, and a considerable amount of dredging was done between Point Pleasant (82) and Presidents Island (233) during the decline in September. The required work was completed by the latter part of September, and

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all the dredges went to the bank during the passage of a small rise which crested at Cairo on October 3. For the first ten days in October practically no work was done, but as the river once more declined, most of the bars already dredged required redredging, while several new shoals claimed attention. By November 10 the channel was once more in satisfactory condition, and after that date but a small amount of work was required at three or four localities until the low water in the latter part of December, when the five dredges still in the field were all employed. Throughout the season channels with least depths of 9 feet and over were maintained through all bars except at Presidents Island, where on several occasions depths of 8 and 8½ feet were found. The material of which this bar is composed is a very compact gravel, extremely difficult to move with a hydraulic dredge. Progress was very slow, and the wear on the pump and pipes severe, culminating in the complete breakdown of the *Iota's* main pump on December 28. Insufficient depths were found here September 17 to 22, October 25 and 26, November 28 to December 13, and December 24 to 26, at stages of about 4, 3, 3 to 1.8, and 0.8 to 0.65, respectively, on the Memphis gauge.

DISCUSSION OF RESULTS.

The results obtained at each bar where dredging was done are briefly discussed below. Plates 2 to 53 illustrate these results at the more important localities. The first plate of each series shows the total area afterwards dredged, but each subsequent plate of the series shows only the area dredged prior to that survey.

Nolans Crossing (76). No plate.—Dredging was not required here until the low water of December, when the *Delta* was operated between the 24th and the 30th. The material moved was sand and gravel. The least depth found during the season was 9 feet, about December 22.

Point Pleasant reach (82–83). Plates 2–6.—As in former years a considerable amount of dredging was required in this locality. No work was needed in the upper portion of the reach, the only troublesome crossing being that from Darnells Towhead to Linda Landing. Plate 2 shows the condition of this crossing in the latter part of August, before any work was done. The channel passed over two distinct reefs, one near the upper, the other near the lower end of the crossing. The first dredging was done by the *Delta*, August 27 to September 3, and September 5 to 7, a cut being made through the upper reef. Plate 3 shows the result of this work. A good, well-defined channel with a depth of 13½ feet was formed. The dredge was then moved to the lower reef, where dredging was done September 10 to 14. This work resulted in a clearly-defined channel of 14 feet depth, as shown on plate 4. This plate also shows some shoaling in the cut through the upper reef, though the depth was still not less than 11 feet. During the rise in the latter part of September some filling occurred in both cuts, but no dredging was required until October 10, when the *Delta* was put to work in the upper reef, where she worked until the 25th. She was then dropped down to the lower reef, where she produced a good, wide, deep channel in two days. Plate 5 shows conditions near the end of October. There was then 13½ feet of water over the crossing, and the channels were well defined. No further work was required at this locality during the season, not less than 11 feet being found at any time. The channels maintained themselves excellently, and even improved, as shown by plate 6, from survey of December 15 and 16. The material moved at this bar was sand, gravel, mud, and blue clay.

Joe Eckles bar (92). Plates 7–8.—At the beginning of the season the channel went down to the left of a middle bar, as shown on plate 7. The current, however, manifested a strong tendency to break through to the right bank above the bar, some evidence of this tendency being shown by the plate. When dredging was required, therefore, this upper line was selected, and the *Delta* dredged here from September 19 to 28. The results of the work are shown by plate 8. About October 20 the *Henry Flad* dredged two days here, extending the *Delta's* cut upstream, but no further work was required during the season. The choice of the upper channel was justified in a marked manner by the subsequent history of this crossing. The dredged channel continued to improve, and remained in good condition till the end of the season, the minimum depths found being 10½ and 11 feet, while the old channel became impassable. The material moved was sand, gravel, blue mud, and drift.

Reelfoot Crossing (100). Plates 9–10.—At the beginning of the season the channel here followed the left bank all the way down the bend from near Reelfoot Landing. Early in August, however, as the river fell, this channel became very narrow and hard to run about a mile below the landing, and complaint was made by steamboat interests. An examination of the locality disclosed a channel leaving the left bank above Reelfoot and crossing over to Island 14, returning to the left bank at Burnleys (100). There was not less than 11 feet in this channel at this time. The *Henry Flad*

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dredged here September 1 to 8, cutting through a reef which crossed the channel off Burnleys Landing, and producing a 13½-foot channel. One week later, as shown on plate 9, there was barely 10 feet through this cut, and a new channel, wide and deep, was opening over a mile below. At the head of the channel there was a bar, through which a cut was made by the *Henry Flad* September 20 to October 1. Operations were suspended on October 1 because of a rising river, and were resumed on the 13th, the work being finished on the 15th. The results of the work are shown on plate 10, which also shows the further deterioration of the channel first dredged. The new channel maintained itself well, but was difficult to run, especially at night, because of the absence of any well-defined marks that could be used as guides. A new opening through the reef, higher up and nearer the shore, was accordingly made by the *Henry Flad* November 1 to 3. No further trouble was experienced at this locality during the season, a least depth of 10 feet being found during the lowest water. The material moved consisted of sand, gravel, blue mud, and some logs and drift.

Foot of Island 16 Crossing (120). Plates 11–12.—At the beginning of the season the channel here crossed the reef well toward its upper end, but as the season advanced a marked tendency to cut through the reef lower down developed. This is seen on plate 11, which shows conditions just before dredging. The *Henry Flad* dredged here September 11 to 15, producing a good 12½-foot channel, which rapidly improved and remained in excellent condition throughout the season. The conditions after dredging are shown by plate 12. An examination of these two plates may suggest the question whether the channel would not have opened itself had no dredging been done. Such an action, however, would be unusual, and it seems more probable that the development of this channel should be credited to the training effect on the current produced by a well-marked and well-located dredged cut. The materials moved at this bar were sand, gravel, and blue mud.

Foot of Island 21 Crossing (133). Plates 13–18.—This crossing, formerly called Miss Hickman's Crossing, has been dredged each year since 1898, and shoal water here was therefore anticipated this season. Up to about September 10, however, the channel remained in good condition. Plate 13 shows the crossing on that date. The reef is seen to be quite wide, with a divided channel, the lower fork of which was selected for improvement. Plate 14, ten days later, shows the results of dredging by the *Kappa*, September 11 to 15. The river had fallen 1½ feet in the interval, but the 9-foot contour at low water runs through the cut, which is well defined. One month later, after a 5-foot rise had passed, conditions were practically unchanged, though the channel had become more crooked and showed some shoaling at the lower end, as shown by plate 15. From October 24 to 28 the *Henry Flad* was engaged in widening and straightening the channel. This was successfully accomplished, and the channel maintained itself well during the long, gradual decline that set in about November 5. Plate 16 shows conditions on November 19, twenty-two days after this dredging was completed. Three weeks later conditions were as shown in plate 17, the river having fallen 2½ feet in the interval. The dredged channel was still in good condition, but shoal spots were developing above the cut and beyond its funnelling effect and the consequent scour. Plate 18 shows an extension of this shoal area above the cut after a further fall of 0.7 foot, but a 9-foot channel of ample width still exists. The river subsequently declined nearly a foot at this point, but this decline was accompanied by scour in the cut and above, and a depth of not less than 9 feet was maintained. The *Henry Flad* was ordered to the crossing on the 23d, at the time of the lowest water, but though she reached the locality on the 24th, she was delayed by high winds, and dredging was not begun till the 28th. Dredging was continued until the morning of the 31st, when operations were suspended, owing to a rapidly rising river. The material moved at this bar was sand and gravel.

New Haven (162). No plate.—At the beginning of the season a channel of ample depth went down the shore below New Haven Landing, following the concave bank. For about 2 miles this channel, with a width varying from 300 to 1,000 feet, lay between the caving bank and an extensive series of sand bars and reef. As it was feared that these conditions might produce narrowing and shoaling, and as the operation of a dredge at this place, if rendered necessary, would block the channel almost completely, it was decided to open an outside channel around the bar. This was done by the *Zeta*, September 13 to 17. The channel down the shore, however, continued to improve as the season advanced, never having less than 10 feet of water in it, and as it was much easier to run than the outside channel the latter was never used. It maintained itself well, however, till late in the season, and could doubtless have been kept open had the shore channel closed, as apprehended. The material moved was sand and blue mud.

Bullerton Towhead or Last Chance Crossing (168). No plate.—This crossing and Random Shot Crossing (194) were the first places requiring dredging, work being

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begun at both on August 22. The first dredging at Last Chance was done by the *Henry Flad*, August 22 to 27, a good 13-foot channel being produced. This work was done on a rising river which experience has shown to be usually undesirable. As the river declined a narrow bar formed across the channel at the lower end of the crossing through which a cut was made by the *Zeta*, September 10 to 12. After this work the crossing rapidly improved, becoming wide and deep, and remaining so until the middle of December, when the low stages reached were accompanied by correspondingly decreased depths. The *Henry Flad* was ordered to the crossing on December 13, but no work was required until the 21st, when all that was needed was done in less than thirty-six hours, a 13-foot channel being produced. The materials moved at this bar were sand, gravel, and mud, with some drift.

Random Shot or Pecan Point Crossing (194–5). Plates 19–24.—As stated above, this crossing was one of the first to require dredging. The steamboat channel at the beginning of the season crossed the reef well toward the upper end, and when depths of only 9½ and 9 feet were found, August 18 and 20, the *Kappa* was put to work in this channel without waiting for a survey. She worked from August 22 to 26, the conditions after these operations being shown on plate 19. A fairly wide channel 10½ feet deep is shown following the dredged cut, but the formation of a new channel a mile below is plainly foreshadowed, the 9-foot contours being much closer together there. A strong current, too, was going that way. Dredging was begun by the *Kappa* in this new channel August 30, and continued till September 3. Conditions at this time are shown on plate 20. Some improvement over the area dredged is noticeable, but shoaling has occurred above. A cut was made through this upper shoal September 5 to 7. Plate 21 shows conditions ten days after this last work, and two weeks after the work on the lower part of the crossing. The channel is seen to have shifted and changed and to have filled considerably on the lower side, with consequent narrowing, but the depth is still satisfactory. From September 20 to 24 the *Epsilon* dredged in about the same place as the *Kappa* had done at the beginning of the month, widening and deepening the lower side of the *Kappa's* channel. This was successfully accomplished. About this time a small rise passed down the river, and after its passage a marked improvement in conditions at this crossing appeared. This is shown by plate 22, where a wide, deep, and straight channel is divided by a small lump at the lower end. Conditions remained good until the latter part of November, when considerable shoaling was found to have taken place, as shown by plate 23. There was still a 9-foot channel, but very crooked, and the *Epsilon* was accordingly placed in the crossing and operated from December 1 to 5. Plate 24 shows the results of this work. During the balance of the season the required depths were found on this crossing and no further work was needed.

The difficulty experienced in opening this channel and the great changes that took place during the season were doubtless due to its location just below a rapidly caving bank, the sand from which was continually washed down onto the crossing. The material moved was sand, with some mud in the first channel dredged. This first channel closed completely as the season advanced.

Walls, or Denfords, Crossing (198). Plates 25–28.—Dredging was not required at this crossing until the second fall in the river, about the middle of October. Plate 25 shows conditions at the end of September. As the river fell, shoaling developed and dredging became necessary, the *Epsilon* working here from October 13 to 20 and on October 23. The effect of this dredging is clearly shown on plate 26, which also shows the great increase of shoal area since September 30. The channel remained in satisfactory condition until the early part of December, when, with the river at a stage of 1 foot below standard low water at Fulton, there was still a channel 9 feet or more deep, but less than 250 feet wide at the narrowest part, as shown by plate 27. The channel was widened by the *Epsilon* December 8 to 11, with the results shown in plate 28. This plate also shows the decrease in available depth and width above the last cut in the locality of the upper part of the *Epsilon's* October work. As the river continued to fall, dredging was required in this part of the crossing. The *Epsilon* was placed in position there December 21 and completed the work assigned to her on the 31st, when the rapid rise in the river made further work unnecessary. The material moved at this crossing was sand, with some gravel in December.

Corona Crossing (203). Plates 29–33.—Conditions at this locality at the end of August are shown on plate 29. The bar was wide and long, with no very clearly marked channel, though at this date there was ample depth over almost any part of it. An examination of this map and an actual observation of the current and other indications on the spot led to the belief that the best location for the channel was toward the lower end of the reef, and the *Zeta* was accordingly operated there from August 30 to September 4. The results of this work were not at all satisfactory. As

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shown by plate 30, three days after dredging, the cut is very ill defined, though the best channel, a rather crooked one of barely 9 feet depth, lies in the locality where the dredge had operated. It was apparent that the first cut had been located too far downstream, and the second dredging, by the *Epsilon*, September 9 to 16, was done somewhat higher up. Plate 31 shows this work to have been successful. A good, well-defined channel was produced, which was still in good condition a month later, as shown by plate 32. The river men, however, were not satisfied with its location, as it required them to run down close to the lower bar in making the crossing, which they never willingly do. For this reason, when dredging became necessary owing to the declining stages in October, a location still higher up was chosen, where the *Epsilon* worked October 24 to November 4. This work was eminently successful; as shown by plate 33, a wide, straight, well-defined channel was produced, much easier to run than any that had existed here up to this time. This channel maintained itself well during the rest of the season, having not less than 10 feet in it, even at the lowest stage reached, while the earlier channels closed completely. A study of the series of plates of this locality seems to indicate that there was from the first a tendency for the channel to go this way, and that had this line been selected for improvement at the beginning a satisfactory channel would have been secured sooner and maintained with less difficulty. The experience at this crossing illustrates anew the necessity of a proper location of the channel in order to insure success. The material moved at this bar was sand and gravel.

Presidents Island Crossing (233–234). Plates 34–40.—This crossing was the most troublesome one of the season, and the only one over which a depth of 9 feet was not maintained. At the beginning of the season there were two channels through the reef, about a mile apart. In the upper channel, the bottom was a very hard and compact gravel, almost impossible to move with a hydraulic dredge, while in the lower channel the bottom was sand. On account of this difference in the material the lower channel was selected for improvement, in the belief that when once made it could be maintained. The *Epsilon* was accordingly operated in the lower channel from September 3 to 8, conditions before and after this work being shown by plates 34 and 35. This work produced no apparent effect, the depth in the lower channel being reduced to less than 9 feet, as shown by plate 35; though, as shown by the same plate more than 9 feet was still found the upper way in the channel followed by the steamboats. It was decided to make another attempt to open the lower channel, and the *Iota* dredged there from September 10 to 17. The progress of the work was closely watched, and on the 16th depths of 11 feet and over were found here, except just on the lower reef, where a depth of 9 feet was found. On the 17th, however, the channel had shoaled to 6 feet; and alongside the dredge, where two cuts to a depth of 18 feet had been made less than twenty-four hours before, less than 9 feet was found, the dredged cuts being entirely obliterated. This remarkable shoaling proved the impossibility of maintaining a channel at this point, and the dredge was ordered to the bank to await the results of a survey, which is shown on plate 36. During this time the river had been falling, and, as shown by the plate, the depths in the upper channel had become less than 9 feet, though a good wide channel 8 feet deep and over still existed. The *Iota* was at once placed in the upper channel, where she dredged from September 23 to October 1, making very slow progress because of the refractory character of the material. Plate 37 shows the results of this work. The 7-foot contour at low water runs through the cut, and as the river had risen 3 feet in the interval a channel of ample width and depth existed. The rise culminated October 6 at 7.2 on the Memphis gauge, after which a decline set in, reaching 3 feet October 25 to 29. About the middle of October dredging again became necessary, and the *Zeta* worked in the upper channel from October 16 to 22. As shown by plate 38, little or nothing was accomplished by this work. A practicable channel of 8 feet is shown, with a possible channel of 8½ feet, but narrow and crooked. The current was not straight with the cut, which made the channel particularly difficult to run. From the low stage the river rose 2 feet by November 8. Dredging was resumed by the *Zeta* on that date, and was continued until the 14th, when, as shown by plate 39, a narrow, crooked channel of 9 feet and over had been opened. At the end of the month the channel was about 100 feet wide between 9-foot contours and 125 feet wide between 8-foot contours, but it was very difficult to run. Conditions on December 5, with 1.9 on the Memphis gauge, are shown on plate 40. The channel is narrow and tortuous, but it is practicable for steamboats at 8 feet. The *Iota* was sent to the crossing December 7, but being delayed by high winds and the grounding of the steamers *Chisca* and *Kate Adams*, she did not begin dredging until the 12th. Dredging was continued, with delays caused by excessive wear on main pump and discharge pipe in the hold and

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grounding of the pontons, until December 28, when two blades of the main pump runner broke off, totally disabling the dredge. As the river was then rapidly rising, work was suspended for the season. During December depths of 8 and 8½ feet were found by the inspection party between the 1st and the 13th and again on the 25th and 26th. The material moved at this bar was sand, gravel, and drift in the lower channel and very hard, compact gravel in the upper channel.

Fleeces Crossing (244). Plates 41–42.—Dredging was not required at this crossing until the latter part of November, depths of 9½ feet and over being found prior to that time. Conditions just before dredging are shown on plate 41, a wide, 9-foot channel being still found. On account of the extreme width of the bar where crossed by the existing steamboat channel, it was decided to dredge higher up, where the width of the bar was much less. The *Iota* worked here November 20 to 23, but as it soon became evident that the upper channel could not be maintained, she was put in the steamboat channel, where she dredged from November 29 to December 2. Plate 42 shows conditions existing five days after this latter dredging. The increase in depth over that shown on plate 41 is marked, though the river was 2½ feet lower at this time. The obliteration of the upper channel is also shown by this plate. The channel remained in satisfactory condition for the rest of the season. The material moved was sand and gravel.

Polks Crossing (266). Plates 43–46.—The first dredging of the season at this crossing was done by the *Kappa*, September 23 to 26. Conditions before dredging are shown on plate 43. As the reef was short and the material light, a good channel was easily obtained. At the end of the month there was a depth of 13½ feet through the cut, though the dredging was done on a rising river. Conditions ten days later, after a fall had set in, are shown on plate 44. The cut is still well defined, and of ample depth. This channel maintained itself well until early in November, when, as shown by plate 45, some deterioration had taken place. At the stage then prevailing, however, 9 feet could be carried over the reef almost anywhere. The *Iota* did one day's dredging here November 7–8, moving about 33,250 cubic yards of material in thirty hours and thirty-five minutes actual pulling ahead, or 1,087 yards per hour. Plate 46 shows conditions after dredging. The channel remained in satisfactory condition until the low water in the latter part of December, when dredging was again required, the *Kappa* working here from December 22 to 26 and producing an 11-foot channel. The material moved at this bar was sand.

Peters Crossing (272). Plates 47–48.—This crossing, on which a large amount of dredging was done in 1903, required only about thirty-five hours of actual dredging this year. Until October no work was needed, 9 feet and over being maintained by natural agencies. Between October 14 and 16 the *Iota* cut through a narrow bar not over 800 feet wide between 9-foot low-water contours, producing a channel 250 feet wide, with depths of 11 feet and over. Only forty-three and one-half hours was consumed in this work from the time the dredge left the bank until she returned to the bank on completion of the work. Conditions before and after the dredging are shown by the plates. The channel maintained itself well during the remainder of the season, 10 feet being the least depth found by the inspection parties. The material moved was sand.

Montezuma Crossing (311). Plates 49–51.—Dredging was required at this crossing twice during the season. The first work was done by the *Iota* October 29 to 31, a channel with a center depth of 14 feet and a depth of 11 feet and over for a width of 500 feet being produced. Conditions before and after this dredging are shown on plates 49 and 50. The depth having become reduced to 10 feet, the channel was opened the second time by the *Kappa* November 21 to 26, a channel 14 feet deep and 250 feet wide being produced, as shown on plate 51. This channel maintained itself for the rest of the season without further dredging. The material moved at this bar was sand.

Andersons Crossing (359). Plates 52–53.—The first dredging of the season at this crossing was done by the *Kappa* October 10 to 15 and October 20 to 22. Conditions just before dredging are shown on plate 52. The width between the 9-foot contours is rather great, though at the stage then prevailing there was a wide channel of 11½ to 12 feet and over. Conditions twelve days after dredging are shown on plate 53, with the river 4½ feet lower. The cut is clear and well defined and the channel of ample width and depth. Early in November the channel showed some narrowing, and the *Kappa* was again put in to widen it. This was accomplished November 7 to 9, and the channel remained in satisfactory condition for the rest of the season. The material moved was sand and gravel.

Conditions this year at Point Pleasant and foot of Island 21 were about the same as usual. Presidents Island gave more trouble than usual, principally because of the character of the material forming the bar, while Peters was less troublesome than

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heretofore. Cherokee, Hathaway, chute of Island 20, and Gold Dust, all dredged in former years, required no dredging this year, while Nolans, Corona, Montezuma, and Andersons were new places. Random Shot required a much larger amount of dredging than in 1903, when it was first dredged. Fleeces was formerly troublesome, but has not required dredging since 1900, until this year. Based upon the usual suppositions, that the width of each cut is the width of the suction mouth and that the side slopes of the channel are 1 on 2½, the amount of material moved by the dredges during the season was 2,149,734 cubic yards. In 1903 this yardage was 891,098; in 1902, 813,380; in 1901, 1,666,465; in 1900, 1,145,558, and in 1899, 1,612,223.

A summary of the operations during the low-water season of 1904 is given in Table No. 8; a statement of the cost of dredging operations, from April 1, 1904, to April 30, 1905, is given in Table No. 9; and the depths over shoal crossings during the low-water season, as found by the inspection party on the *Search*, are given in Table No. 10.

For additional details attention is invited to the report of Assistant Engineer Wm. Gerig, Appendix 1 E.

SURVEY FOR 14-FOOT WATERWAY, MISSISSIPPI RIVER, FROM THE MOUTH OF THE ILLINOIS RIVER TO ST. LOUIS, MO.

A full history of this survey up to the date of the last annual report is published in the Supplements to the Report of the Chief of Engineers for 1903, page 68, and for 1904, page 53. During the year the reduction and platting of the notes of the field work of 1902 and 1903, in progress at the date of my last annual report, was completed, and a map showing the river and adjacent topography from the mouth of the Illinois River to St. Louis, Mo., was prepared in thirteen sheets, scale 1 to 4,800. Profiles and diagrams of borings were also prepared. From July 13 to September 7 a small party on the steamer *Venus* was engaged in taking topography and levels and making borings along the line of the proposed canal leaving the river at Alton and returning to the river a short distance above the Merchants' Bridge, St. Louis; and in making cross sections and borings for the location of the proposed dam at Alton. Subsequently additional borings were made at the site of the proposed lock; the details of the canal, lock, lock gates, and dam were worked out, detailed drawings made, and estimates of cost prepared. A map of the river from Alton to St. Louis, scale 1 inch to 1 mile, showing the location of the proposed works and a profile along the line of the canal, were prepared and all data submitted to the Commission, whose report with estimates was forwarded to the Chief of Engineers March 2. The field work of the year was directed, the details of the proposed structures worked out, and the estimates of cost prepared by Assistant Engineer F. B. Maltby, acting under special instructions from the president of the Commission.

The following papers accompany this report:

Money statements.

Abstract of contracts in force.

Commercial statistics.

Statement of charts issued and sold.

Appendix 1 A. Laws affecting the Mississippi River Commission, July 1, 1904, to June 30, 1905.

Appendix 1 B. Report of Assistant Engineer W. G. Comber on survey of the Atchafalaya River.

Appendix 1 C. Report of Junior Engineer E. L. Harman on adjustment of precise levels north of Brainerd, Minn.

Appendix 1 D. Report of Assistant Engineer Kivas Tully on gauges, discharge observations, reduction of physical data, and office publications.

Appendix 1 E. Report of Assistant Engineer Wm. Gerig on dredging operations on the Mississippi River between Head of the Passes and mouth of the Ohio River and care and repair of dredging plant.

Table No. 1. Corrected geodetic positions between Bemidji and Grand Rapids.

Table No. 2. Description of stone line bench marks in the vicinity of Aitkin.

Table No. 3. Corrected elevations of precise level bench marks north of Brainerd.

Table No. 4. Highest and lowest gauge readings in 1904, Mississippi River and tributaries.

Table No. 5. Annual highest and lowest gauge readings, 1898 to 1905, at stations on the Mississippi River and tributaries.

Table No. 6. Results of discharge observations, Mississippi River and tributaries.

Table No. 7. Results of meter ratings.

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Table No. 8. Summary of dredging operations, Mississippi River below Cairo during low-water season of 1904.
Table No. 9. Cost of dredging operations, April 1, 1904, to April 30, 1905.
Table No. 10. Depths over shoal crossings, Mississippi River, low-water season of 1904.
Plate 1. Hydrograph of the Mississippi River, Cairo, Ill., to Fort Jackson, La., June 1, 1904, to May 31, 1905.
Plates 2 to 53. Dredge maps.
Respectfully submitted.

WM. B. LADUE,
Captain, Corps of Engineers,
Secretary Mississippi River Commission.

The PRESIDENT MISSISSIPPI RIVER COMMISSION.

Money statements.

[Appropriation for improving Mississippi River.]

July 1, 1904, balance unexpended		$201,088.78
Amount allotted from appropriation by sundry civil act approved April 28, 1904	$387,000.00	
Miscellaneous receipts as follows:		
Amount collected by the Solicitor of the Treasury from the Memphis and Arkansas City Packet Company, as reimbursement for loss of coal from sinking of coal barge by steamer *Kate Adams* on December 27, 1904. Credited to "Dredges and Dredging," April, 1905	78.00	
Amount received from Chicago, Burlington and Quincy Railroad Company for loss of United States property shipped on Government bill of lading No. 70, August 29, 1903, from Minnesota Transfer, Minn., to St. Louis, Mo. Credited to "Surveys, Gauges, and Observations," May, 1905	11.00	
From transfers and sales of engineer property under provisions of section 5 of river and harbor act of June 13, 1902:		
Sales in September, 1903, credited to "Surveys, Gauges, and Observations," October, 1904	3.50	
Sales in February, 1904, credited to "Surveys, Gauges, and Observations," October, 1904	25.00	
Reimbursement for transfer, credited to "Dredges and Dredging," October, 1904	3,000.00	
Sales in October, 1904, credited to "Dredges and Dredging," December, 1904	35.00	
Sales in July, 1902, credited to "Dredges and Dredging," December, 1904	114.35	
Sales in December, 1904, credited to "Dredges and Dredging," January, 1905	16.00	
Sales in March, 1905, credited to "Dredges and Dredging," April, 1905	90.60	
		390,373.45
		591,462.23
June 30, 1905, amount expended during fiscal year		417,473.18
July 1, 1905, balance unexpended		173,989.05
July 1, 1905, outstanding liabilities	$26,009.77	
July 1, 1905, amount covered by uncompleted contracts	139,506.76	
		165,516.53
July 1, 1905, balance available		8,472.52

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[Appropriation for "Gauging waters of the Mississippi River and its tributaries."a]

July 1, 1904, balance unexpended		$2,766.08
Amount allotted by Chief of Engineers, August 11, 1904, from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, as amended by section 9 of river and harbor act of June 13, 1902		9,100.00
		11,866.08
June 30, 1905, amount expended during fiscal year	$9,749.99	
June 30, 1905, amount reverted to Treasury during fiscal year	436.58	
		10,186.57
July 1, 1905, balance unexpended		1,679.51
July 1, 1905, outstanding liabilities		1,240.05
July 1, 1905, balance reverting to Treasury		439.46
Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905		9,100.00

Itemized statement of expenditures during the fiscal year ending June 30, 1905, submitted in compliance with requirement of section 6 of river and harbor act of August 11, 1888.

Observations:		
Pay of permanent gauge observers		$4,526.67
Inspections and repairs:		
Inspection of gauges on Mississippi River by junior engineers and parties on steamers	$1,434.62	
Inspection of gauges on tributaries	174.01	
Renewals and repairs of gauges and bulletins	1,470.58	
		3,079.21
Office expenses and contingencies:		
Pay of assistant and junior engineers, recorders, and clerks	1,920.75	
Stationery, printing, etc	223.36	
		2,144.11
		9,749.99

[Appropriation for Waterway from Lockport, Ill., to St. Louis, Mo.]

July 1, 1904, balance unexpended	$9,153.55
Amount transferred from allotment for "Survey of Illinois and Des Plaines rivers, Ill.," as reimbursement	1,093.40
	10,246.95
June 30, 1905, amount expended during fiscal year	6,428.64
July 1, 1905, balance unexpended	3,818.31
July 1, 1905, outstanding liabilities	17.05
July 1, 1905, balance available	3,801.26

Consolidated statement of appropriations and allotments expended under the secretary, Mississippi River Commission, to June 30, 1905.

[Appropriation for "Gauging Waters of the Mississippi River and its Tributaries."]

Allotments from general appropriations for examinations, surveys, and contingencies of rivers and harbors by acts of—	
March 3, 1871	$5,000.00
June 10, 1872	5,000.00
March 3, 1873	5,000.00
June 23, 1874	5,000.00
March 3, 1875	5,000.00

aThe custody and care of the gauges maintained under this appropriation were assumed by the Mississippi River Commission February 11, 1901, on which date they were transferred to the Secretary, under authority of Secretary of War, dated January 25, 1901.

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Specific appropriations by river and harbor acts of—	
August 14, 1876	$5,000.00
June 18, 1878	5,000.00
March 3, 1879	5,000.00
June 14, 1880	5,000.00
March 3, 1881	5,000.00
August 2, 1882	5,000.00
Deficiency act of March 12, 1884	2,100.00
Specific appropriations by river and harbor acts of—	
July 5, 1884	5,000.00
August 5, 1886	5,000.00
Allotted from specific appropriation by river and harbor act of August 11, 1888	8,700.00
Deficiency act of October 19, 1888	3,600.00
Allotments from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, for fiscal years, viz:	
1890	9,000.00
1891 (less $3,518.34 withheld in United States Treasury under ruling that only $6,000 can be expended each fiscal year)	5,181.66
1892	5,100.00
1893	5,500.00
1894	5,500.00
1895	5,500.00
1896	5,500.00
1897	5,500.00
1898	5,500.00
1899	6,000.00
1900	5,500.00
1901	6,000.00
1902	6,000.00
Allotments from permanent indefinite appropriation made by section 6 of river and harbor act of August 11, 1888, as amended by section 9 of river and harbor act of June 13, 1902, for fiscal years, viz:	
1903	9,100.00
1904	9,100.00
1905	9,100.00
Total	182,481.66

EXPENDED.

	To June 30, 1904.	During year ending June 30, 1905.	Total.
Expenditures	$162,256.37	$9,749.99	$172,006.36
Unexpended balances reverted to Treasury	8,359.21	436.58	8,795.79
Total	170,615.58	10,186.57	180,802.15
Unexpended balance June 30, 1905			1,679.51
Total appropriated, etc.			182,481.66

[Appropriation for "Waterway from Lockport, Ill., to St. Louis, Mo."]

Act of June 13, 1902 (river and harbor)	$25,000.00
Amount transferred from allotment for "Survey of Illinois and Des Plaines rivers, Ill.," as reimbursement	1,093.40
Total	26,093.40

EXPENDED.

	To June 30, 1904.	During year ending June 30, 1905.	Total.
Expenditures	$15,846.45	$6,428.64	$22,275.09
Unexpended balance June 30, 1905			3,818.31
Total appropriated, etc.			26,093.40

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Abstract of contracts entered into by Capt. Wm. B. Ladue, Corps of Engineers, in force June 30, 1905—Improving Mississippi River, Mississippi River Commission, secretary's office.

Contractor.	Amount and character of work.	Price.	Date of contract.	Date of approval.	Date of beginning work.	Date of expiration.
C. Jutte & Co	Furnishing 450,000 bushels coal.	[a] $0.09	1905. Apr. 17	1905. May 9	1905. May 22	1906. June 30
The Springfield Boiler and Manufacturing Co.	Constructing self-propelling hydraulic dredge and ponton pipe line.	238,998.17	Apr. 21	June 15	June 29	Dec. 12

[a] Per bushel.

Commercial statistics for calendar year 1904.

TABLE No. 1.

Tonnage between—	Number of passengers.	Receipts and shipments, in tons. Grain and its products.	Cotton.	Cotton seed and its products.	Live stock.	Coal and coke.	Lumber.
St. Louis and Cairo	72,497	26,699	471	1,481	16,266	108,955	38,510
Cairo and Memphis	57,191	8,782	15,455	12,064	618	1,250,467	192,481
Memphis and Vicksburg	106,292	16,017	87,581	52,757	3,966	1,077,693	76,357
Vicksburg and New Orleans	87,796	23,878	46,997	63,901	4,858	1,020,500	25,358

Tonnage between—	Receipts and shipments, in tons. Logs.	Iron, steel, and metals.	Groceries and provisions.	Stone, sand, and gravel.	Miscellaneous and unclassified.	Total.
St. Louis and Cairo	65,990	1,400	18,581	14,559	93,574	386,486
Cairo and Memphis	503,465	43,549	3,745	29,700	92,978	2,153,254
Memphis and Vicksburg	630,226	16,246	28,739	19,000	32,016	2,040,598
Vicksburg and New Orleans	133,638	116,371	118,458	377,415	[a] 186,466	2,117,840

[a] Includes 111,624 tons of oil.

NOTE.—Each stretch is treated as a separate river, and tonnage carried between ports on different stretches will appear in the statistics of all intervening stretches. Consequently, the sum of the tonnage carried in the four stretches does not represent the total traffic on the river as a whole.

During the year the St. Louis and Mississippi Valley Transportation Company, which for years has been the principal carrier of grain and other bulk freight between St. Louis and New Orleans, disposed of its equipment, consisting of 3 large towboats and 30 barges, to the Monongahela River Consolidated Coal and Coke Company, and retired from business.

TABLE No. 2.—*Receipts and shipments at principal ports.*

Ports.	Passengers carried in and out of port.	Receipts and shipments, in tons. Grain and its products.	Cotton.	Cotton seed and its products.	Live stock.	Coal and live coke.	Lumber.
St. Louis, Mo	[a] 947,913	32,221	513	1,481	25,017	108,321	40,918
Memphis, Tenn	100,187	10,260	24,918	20,155	2,010	171,084	93,588
Vicksburg, Miss. [b]	34,907	4,519	52,934	31,887	962	70,300	8,816
New Orleans, La. [c]	22,489	341,345	574,343	315,858	4,936	1,025,252	549,075

Ports.	Receipts and shipments, in tons. Logs.	Iron, steel, and metals.	Groceries and provisions.	Stone, sand, and gravel.	Miscellaneous and unclassified.	Total.
St. Louis, Mo	36,879	1,799	18,424	.....	112,362	377,935
Memphis, Tenn	212,030	28,316	13,224	25,200	64,009	664,744
Vicksburg, Miss. [b]	125,000	3,992	5,476	.....	19,123	323,009
New Orleans, La. [c]	202,763	31,522	796,477	72,665	[d] 997,270	4,911,506

[a] Includes 762,696 passengers in local excursion traffic.
[b] The traffic on the Yazoo River and its tributaries not included.
[c] Includes exports and imports and the domestic coastwise traffic as far as reported.
[d] Includes 349,189 tons of oil.

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TABLE No. 3.—*Seagoing traffic at New Orleans, La.*

Arrivals and departures:	
Foreign-bound vessels—	
Number	
Tonnage	3,19
Coastwise vessels—	
Number	
Tonnage	1,24
Totals—	
Number	
Tonnage	4,44
Receipts and shipments;	
Grain and its products	317
Cotton	524
Cotton seed and its products	281
Live stock	1
Coal and coke	3
Lumber	524
Logs	39
Iron, steel, and metals	11
Groceries and provisions	682
Oils (fuel or mineral)	237
Miscellaneous and unclassified	628
Total	3,251

TABLE No. 4.—*Ferry traffic.*

Location of ferries and transfers.	Number of passengers.	Tonnage of freight carried.					
		Grain and its products.	Cotton.	Cotton seed and its products.	Live stock.	Coal and coke.	Lumb
St. Louis, Mo	1,578,614	143,645	4,788	.....	.....	137,953	95,7
Ste. Genevieve, Mo.; Chester, Ill.; Cape Girardeau, Mo.; Grays Point to Thebes and Gale, Ill.; Commerce, Mo	115,897	19,729	23,172	31,201	4,932	209,812	739,9
Cairo, Ill., to Birds Point, Mo., Wickliffe, Ky., and Greenfield, Mo	90,055	75,289	2,579	1,947	11,172	8,201	171,1
Belmont, Mo., to Columbus and Hickman, Ky.; Ashport, Tenn.; Hales Point, Tenn	6,588	.....	.....	.....	.....	.....	.....
Memphis, Tenn., to Hopefield, Ark., and West Memphis, Ark	120,000	36,125	18,867	12,175	5,192	44,585	38,10
Helena, Ark.; Trotters Point, Ark.; Arkansas City, Ark	63,119	4,781	11,194	6,591	402	15,128	17,18
Vicksburg, Miss.; Delta Point, La	95,263	5,131	323	185	4,302	61,113	4,13
Natchez, Miss., to Vidalia, La.; Bayou Sara, La.; Baton Rouge, La.; Donaldsonville, La	147,384	973	7,661	200	1,444	1,757	520
New Orleans, La	2,636,001	256,185	145,733	101,415	52,499	86,654	243,89

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TABLE No. 4.—*Ferry traffic*—Continued.

Location of ferries and transfers.	Tonnage of freight carried.					
	Logs.	Iron, steel, and metals.	Groceries and provisions.	Sand, gravel, and stone.	Unclassified and miscellaneous.	Total.
St. Louis, Mo	.....	47,882	20,000	979,678	5,725,642	7,155,352
Ste. Genevieve, Mo.; Chester, Ill.; Cape Girardeau, Mo.; Grays Point to Thebes and Gale, Ill.; Commerce, Mo.	126	29,766	24,392	9,000	163,692	1,255,812
Cairo, Ill., to Birds Point, Mo., Wickliffe, Ky., and Greenfield, Mo.	550	3,982	168,017	.....	231,608	674,379
Belmont, Mo., to Columbus and Hickman, Ky.; Ashport, Tenn.; Hales Point, Tenn	.....	.....	1,500	.....	126,643	128,143
Memphis, Tenn., to Hopefield, Ark., and West Memphis, Ark	12,060	11,870	67,325	60,750	88,960	396,014
Helena, Ark.; Trotters Point, Ark.; Arkansas City, Ark	7,246	280	4,137	.....	19,905	86,808
Vicksburg, Miss; Delta Point, La	.....	21,608	2,233	.....	393,346	492,377
Natchez, Miss., to Vidalia, La.; Bayou Sara, La.; Baton Rouge, La.; Donaldsonville, La	10,000	71	1,402	.....	41,075	65,103
New Orleans, La	16,000	81,664	60	.....	1,438,708	2,422,807

Statement of maps and charts issued and sold from July 1, 1904, to June 30, 1905—Improving Mississippi River, Mississippi River Commission, secretary's office.

Description.	Free.	Sold.	Total.
Upper alluvial valley map	96	17	113
Lower alluvial valley map	105	60	165
Inch-to-mile map	3,143	1,804	4,947
Detail chart, 1:20,000 scale	1,099	587	1,686
Detail chart, 1:10,000 scale	1,365	31	1,396
Detail chart, 1:10,000 scale (harbor of New Orleans)	4	184	188
District map of lower Mississippi River	1	1	2
Lake Itasca Basin	12	2	14
St. Francis Basin	378	23	401
Total	6,203	2,709	8,912

Proceeds deposited with the assistant treasurer of the United States at St. Louis, Mo., $326.44.

APPENDIX 1 A.

LAWS AFFECTING THE MISSISSIPPI RIVER COMMISSION, JULY 1, 1904, TO JUNE 30, 1905.

[PUBLIC—No. 215.]

AN ACT Making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums of money be, and are hereby, appropriated, to be paid out of any money in the Treasury not otherwise appropriated, to be immediately available, and to be expended under the direction of the Secretary of War and the supervision of the Chief of Engineers, for the construction, completion, repair, and preservation of the public works hereinafter named:

* * * * * * *

Improving the Mississippi River from the Head of the Passes to the mouth of the Ohio River, including salaries, clerical, official, traveling, and miscellaneous expenses

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of the Mississippi River Commission: Continuing improvement, one million dollars, which shall be expended under the direction of the Secretary of War in accordance with the plans, specifications, and recommendations of the Mississippi River Commission as approved by the Chief of Engineers for the general improvement of the river, for the building of levees, and for surveys, including the survey from the Head of the Passes to the headwaters of the river, in such manner as in their opinion shall best improve navigation and promote the interests of commerce at all stages of the river: *Provided*, That on and after the passage of this act a contract or contracts may be entered into by the Secretary of War for such materials and work as may be necessary to carry on continuously the plans of the Mississippi River Commission as aforesaid, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate two million dollars, exclusive of the amounts herein and heretofore appropriated, which latter amount may be expended during the year beginning July first, nineteen hundred and six: *Provided further*, That the money hereby appropriated and authorized to be expended, in pursuance of contracts or otherwise, or so much thereof as may be necessary, shall be expended in the construction of suitable and necessary dredge boats and other devices and appliances and in the maintenance and operation of the same, with the view of ultimately obtaining and maintaining a navigable channel from Cairo down not less than two hundred and fifty feet in width and nine feet in depth at all periods of the year, except when navigation is closed by ice: *And provided further*, That the water courses connected with said river, and the harbors upon it, now under the control of the Mississippi River Commission and under improvement, may, in the discretion of said Commission, upon approval by the Chief of Engineers, receive allotments for improvements now under way or hereafter to be undertaken, to be paid for from the amounts herein appropriated or authorized.

* * * * * * *

For emergencies: To provide for the restoration of channels or river and harbor improvements heretofore established or made by the Government, or herein provided for, where by reason of emergency occurring after the passage of this act the usual depth of such channels or customary use of such improvement can not be maintained and there is no sufficient fund available for such restoration, three hundred thousand dollars. The amount herein provided shall be allotted by the Secretary of War: *Provided*, That in no case shall such allotment be made unless recommended by the local engineer having such channel or improvement in charge, and by the Chief of Engineers, respectively: *Provided further*, That for no single channel or improvement shall a sum greater than ten thousand dollars be allotted.

* * * * * * *

Appropriations made for the respective works herein named, or so much thereof as may be necessary, may, in the discretion of the Secretary of War, be used for maintenance and for the repair and restoration of said works whenever, from any cause, they have become seriously impaired, as well as for the further improvement of said works.

Surveys and examinations provided for in this section shall, unless otherwise expressed, be paid for from the appropriations made for the respective improvements or projects to which they pertain, or in connection with which they are mentioned.

All works of improvement heretofore or herein authorized to be prosecuted or completed under contracts may, in the discretion of the Secretary of War, be carried on by contract or otherwise, as may be most economical or advantageous to the United States.

Where separate works or items are consolidated in this act and an aggregate amount is appropriated therefor, the amounts herein appropriated shall be expended in securing maintenance and improvement according to the respective projects herein or heretofore adopted by Congress, after giving due regard to the respective needs of traffic. The allotments to the respective works herein consolidated shall be made by the Secretary of War upon recommendations by the Chief of Engineers. In case such works or items are consolidated and separate amounts are given with each project, the amounts so named shall be expended upon such separate projects, unless in the discretion of the Secretary of War another allotment or division should be made of the same. Any balances now remaining to the credit of the consolidated items in this act shall be carried to the credit of the respective aggregate amounts appropriated for the consolidated items herein contained.

* * * * * * *

SEC. 9. That the Secretary of War is hereby directed to cause preliminary examinations or surveys to be made at the localities named in this section as hereinafter provided. In all cases, unless a survey or estimate is herein expressly directed, a

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preliminary examination shall first be made which shall embrace information concerning the commercial importance, present and prospective, of the river or harbor mentioned, and a report as to the advisability of its improvement. Whenever such preliminary examination has been made, in case such improvement is not deemed advisable, no surveys thereof or estimate therefor shall be made without the direction of Congress; but in case the report shall be to the effect that such river or harbor is worthy of improvement, or that a survey and estimate should be made to determine the advisability of improvement, the Secretary of War is hereby directed, at his discretion, to cause surveys to be made and the cost of improvement of such river or harbor to be estimated and reported to Congress: *Provided*, That in all cases preliminary examinations as well as surveys shall be examined and reviewed by the board provided for in section three of the river and harbor act of June thirteenth, nineteen hundred and two. Such examination and review shall be made by the said board of all examinations or surveys provided for in this act, whether contained in section one or section ten; said board shall also, on request by resolution of the Committee on Commerce of the United States Senate, or the Committee on Rivers and Harbors of the House of Representatives, examine and review surveys provided for by acts or resolutions prior to the river and harbor act of June thirteenth, nineteen hundred and two, and report thereon: *Provided further*, That at any time prior to the assembling of Congress in December, nineteen hundred and five, all reports of preliminary examinations and surveys that may be ready for printing shall, in the discretion of the Secretary of War, be printed by the Public Printer as documents of the Fifty-ninth Congress.

* * * * * * *

TENNESSEE.

Mississippi River, from the town of Ashport, Tennessee, to the highlands above overflow at or near the town of Fort Pillow, and from Ashport east to the highlands above overflow in Lauderdale County, with a view to improving navigation of said section of the river and preventing overflow.

* * * * * * *

Approved, March 3, 1905.

[PUBLIC—No. 216.]

AN ACT Making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, nineteen hundred and six, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, for the objects hereinafter expressed, for the fiscal year ending June thirtieth, nineteen hundred and six, namely:

* * * * * * *

UNDER THE WAR DEPARTMENT.

* * * * * * *

UNDER THE MISSISSIPPI RIVER COMMISSION.

Improving Mississippi River: For continuing improvement in completion of contract authorization of Mississippi River from Head of Passes to the mouth of the Ohio River, including salaries and clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission, two million dollars.

* * * * * * *

Approved, March 3, 1905.

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TABLE No. 1.—*Geographical positions north of St. Paul, Minn., Bemidji, Minn., to Grand Rapids, Minn.*

[Determined by tapeline and azimuth. Referred to the Cairo astronomical post.]

NOTE.—The geographical positions of this stretch, as published in Report of Chief of Engineers for 1901, supplement, pages 65–66, are subject to correction for an error made in the first computation, near Bemidji, and for closure at Blackberry Station with taped line of 1902 from end of triangulation at Aitkin, Minn. The following corrected positions are from recomputation and adjustment made by Assistant Engineer Geo. H. French in 1903:

Station.	Latitude.			Seconds.	Longitude.			Seconds.	Azimuth.			Back azimuth.			To station.	Distance.
	°	′	″	*Meters.*	°	′	″	*Meters.*	°	′	″	°	′	″		*Meters.*
Wolf Lake	47	25	26.34	812.7	94	40	50.48	1,060.5	325	23	49.0	145	23	59.6	Target No. 10	531.2
Spring	47	22	38.08	1,174.3	94	38	31.42	659.4	270	45	04.3	90	46	00.0	Wye	1,587.9
P. B. M. Midge	47	22	45.59	1,409.0	94	43	46.70	980.7								
P. B. M. Wye	47	22	31.21	964.1	94	37	20.12	422.3	205	37	33.7	25	37	36.9	Wye	212.0
Wye	47	22	37.40	1,154.9	94	37	15.75	330.4	245	01	05.5	65	01	27.1	Cass Lake	671.0
									255	44	45.0				Water tower	
									270	06	30.0				Milepost 165	
Cass Lake	47	22	46.57	1,438.1	94	36	46.75	980.8								
U. S. E. B. M. 347	47	22	18.86	582.4	94	35	42.51	891.9								
Chippewa	47	22	35.81	1,105.8	94	33	45.31	950.6	91	20	30.0				Milepost 163	
U. S. E. B. M. 342	47	22	28.20	870.8	94	33	22.15	464.7								
Pike Bay	47	22	25.84	797.9	94	32	51.21	1,074.4	296	24	57.9	116	25	19.9	Lomond	702.0
									92	14	00.0				Milepost 162	
									297	16	00.0				Signpost "1 mile to S."	
Lomond	47	22	15.72	485.4	94	32	21.25	445.8	270	22	15.9	90	24	25.6	Cuba	3,696.6
									270	48	30.0				Milepost 161	
									270	20	00.0				Southeast corner of house	
Cuba	47	22	14.91	460.4	94	29	25.07	526.0	273	44	00.0				Milepost 159	
									90	18	30.0				Milepost 160	
Schley	47	21	37.28	1,151.2	94	21	12.00	251.8	278	50	00.0				Milepost 152	
									103	15	20.0				Gable of section house	
Portage	47	21	09.20	284.1	94	16	55.91	1,173.5	279	12	12.5	99	14	24.8	Bigosh	3,823.9
									278	31	00.0				Mile post 149	
									279	07	00.0				Gable of warehouse	
Bigosh	47	20	49.36	1,524.2	94	13	56.08	1,177.7	278	56	55.3	98	57	37.2	Bena	1,210.0
									278	44	00.0				Mile post 146	
									99	24	00.0				Mile post 148	
Bena	47	20	43.26	1,335.9	94	12	59.14	1,241.9	276	48	30.7	96	50	37.7	Norway Grove	3,651.4
									275	08	00.0				Water tank	
									279	00	00.0				West gable of warehouse	
									99	13	00.0				Mile post 147	
									99	14	40.0				Sign: "1 mile to S."	
Norway Grove	47	20	29.21	902.0	94	10	06.43	135.0	276	37	00.0				Mile post 143	
									98	30	00.0				Mile post 144	
Divide	47	19	45.98	1,418.3	94	01	17.24	362.0	99	16	20.0				Mile post 137	
									97	26	40.0				Sign: "1 mile to S."	
B. M. Mississippa																

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B. M. Tomahawk	47	19	21.47	663.0	93	56	20.92	439.3	275	17	30.0				Gable section house	
									97	39	30.0				Sign: "Stop"	
									266	58	00.0				Mile post 133	
B. M. Wigwam	47	19	16.45	508.0	93	54	59.86	1,257.1	237	51	11.9	57	52	26.4	(A) Starke	2,513.0
									237	16	00.0				Sign: "1 mile to drawbridge"	
									237	33	00.0				Corner drawbridge	
(A) Starke	47	19	59.74	1,844.8	93	53	18.52	388.9	58	15	00.0				Sign: "1 mile to drawbridge"	
									318	05	00.0				Gable of house	
(A) Old Road	47	20	20.16	622.5	93	48	34.33	720.9	301	30	15.0	121	31	07.6	(A) Deer River	1,761.5
									300	34	00.0				Water tank	
									79	24	50.0				Road-crossing sign	
(A) Deer River	47	19	50.35	1,554.8	93	47	22.80	478.8	5	49	12.9	185	49	09.8	B. M. Round House	875.5
									128	52	00.0				Water tank	
									126	16	00.0				Flagstaff	
B. M. Round House	47	19	22.14	688.7	93	47	27.03	567.6								
B. M. Cohasset	47	15	49.13	1,517.1	93	37	26.87	565.1	295	24	00.0				6 inches north of line of north rail on tangent to E.	
B. M. Dam	47	15	04.43	136.8	93	35	08.34	175.4	309	33	40.0	129	34	55.0	(A) Grand Rapids	2,820.0
(A) Grand Rapids	47	14	06.26	193.3	93	33	24.98	525.6	269	35	20.0				Water tank	
B. M. Grand Rapids	47	14	04.60	142.0	93	31	17.96	377.9	295	50	18.3	115	52	33.0	(A) La Prairie	4,288.0
									89	38	20.0				Court-house dome	
									108	33	20.0				Schoolhouse cupola	
(A) Race Track	47	13	49.87	1,540.0	93	31	29.11	612.5	207	16	40.5	27	16	48.7	B. M. Grand Rapids	512.0
(A) La Prairie	47	13	04.05	125.1	93	28	14.54	305.9	304	28	00.0				Milepost 108	
									115	27	00.0				Milepost 109	
									115	49	00.0				Flagstaff G. R	
B. M. Blackberry	47	11	20.57	635.2	93	24	25.27	531.9	303	45	20.0				Mail pouch derrick	
									303	40	00.0				Southwest corner tool house	
									123	01	00.0				Milepost 106	
									111	48	00.0				Milepost 105	
									287	00	00.0				Gable schoolhouse	

[a] B. M. Mississip was moved by railroad company in June, 1904, and its new position has not been reliably ascertained.

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APPENDIX 1 B.

REPORT OF ASSISTANT ENGINEER W. G. COMBER ON SURVEY OF ATCHAFALAYA RIVER.

ST. LOUIS, MO., *May 10, 1905.*

CAPTAIN: In compliance with your instructions I have the honor to make the following report on Atchafalaya River survey, made in the months of December and January, 1904–5, under my charge.

Under your instructions of November 19, 1904, the survey was ordered to include soundings with ranges marked for future identification, topography to include shore line and controlling levee lines, precise levels, with either tape line or triangulation measurements as a base for the stadia measurements, and for location of the precise bench marks.

The survey party was organized at Memphis on the steamer *Patrol*, which with a fuel barge was used on the survey, with the following assistants: Geo. H. French, assistant engineer; E. L. Harman, E. J. Thomas, C. L. Vandeburgh, and F. E. Early, junior engineers; 6 recorders, and 35 others, including surveymen, laborers, and steamboat crew.

Owing to delays in receiving marking pipe the party did not leave Memphis until December 3, arriving at Simmesport, 5 miles below Red River, at 3 p. m., December 9.

After a study of the topographic conditions it was determined to carry a taped line down the left bank, on or near the foot of the levee, as promising better results than tertiary triangulation on account of the necessarily small triangles.

The party was subdivided into tape-line party, two topographic parties, precise-level party, ordinary level and flag party, and hydrographic party.

Taped line.—The tape-line party, Assistant French in charge, 1 recorder, and 9 men, began work at precise bench marks 92 and 93 of the Red River survey, using azimuths procured from the Vicksburg office. Stations were established using longest possible lines, and angles repeated between these stations four times, direct and reversed on different parts of the limb, using Berger transit No. 4630, a nearly new 30-inch topographic instrument, and mean of angles taken, with azimuths corrected by observations on Polaris or 51 Cephei, at elongation, about every 6 miles.

Lines between stations were taped with 200-foot steel tape, standard at 60° F., at 16 pounds tension. Lines were twice taped, forward and back, and mean of measurements used, after correction for temperature and slope.

The number of courses taped and stations occupied on main line was 154, and average distance between stations 730 meters; the shortest course, between triangles 72 and 73, 138 meters, and the longest course, between triangles 112 and 113, 1,800 meters.

After completing the line from precise bench mark 93 to precise bench mark 24, at Grand River, the work was again taken up at precise bench mark 93 and extended to bench mark $1\frac{1}{2}^{9}$, thus making a connection with Mississippi River locations. This line should be connected at the first opportunity with the secondary positions in the neighborhood, as it has been found that the location of bench mark $1\frac{1}{2}^{9}$ is a stadia location only.

Azimuth observations at bench mark $1\frac{1}{2}^{9}$ and precise bench mark 24 were not made on account of bad weather and the necessity of disbanding the party to save expense. These observations can be made economically when a party is again in the neighborhood.

The route used was either on or near the levee, until the end of the levee was reached, about 1 mile above the head of the Alabama Bayou and 43 miles from Red River, thence entirely through the woods to Grand River, cutting across the bends whenever practicable to use the shortest and best line.

From the table of distance and azimuth closures[a] I find that the total discrepancy in measurements over the 69.9 miles of taped line is 4.79 feet, or about 1:77,000, and the azimuth error, i. e., excess of large over small closures, about eleven seconds of arc or 19.7 feet, or 1:19,000, and the probable error is inside these limits.

The country is almost an ideal one for this kind of measurement, and to this and the industry and interest of the tape-line party are attributed the apparently good results.

Precise levels.—The precise-level party, Assistant Harman in charge, also began work at precise bench marks 92 and 93 of the Red River survey, and carried a

[a] Not printed.

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continuous duplicate line down the left bank of the river, taking advantage of the tape-line party's cut in the woods. Twenty-four precise bench marks were set and elevations determined, 23 on the left bank and 1 on the right bank at Melville. All of these marks were located by taped line and repeated angles from the main tape line.

In addition to this work the permanent river gauges at Simmesport and Melville were connected with.

The usual methods were used, and the precise bench marks are the regulation tile and pipe adopted by this office.

Ordinary levels.—No use of ordinary levels was made except to determine the river slope, and as the low-water slope was so slight it was thought only necessary to determine this for every mile of river. This was done by duplicate lines of levels from the precise bench marks to the water surface at every fifteenth sounding section. In addition to this work this party laid out sounding sections, buried the marking pipe for the hydrographer, and flagged all connection points for the topographers. The gauges at Melville and Simmesport were inspected by Recorder Eitzen, in charge of the level party.

Hydrography.—Sounding sections were laid out normal to the stream 100 meters apart and marked with range flags. At every fifth range the cross section was extended farther back, and each end marked with a 1¼-inch black iron pipe 5 feet long and set about 3½ feet in the ground. These pipe sections were instrumentally occupied, and azimuths read over the cross section for the purpose of more easily identifying the section at some future time.

The usual method of sounding and location by stadia rod carried in the sounding boat with readings from transit locator on shore was followed.

Number of main cross sections sounded	1,099
Number of side bayou cross sections	45
Cross sections sounded per mile of river	16

In addition to the cross-section soundings a low-water discharge determination consisting of ten observations, five with double floats and five with rod floats, was taken, the discharge section being located about halfway between Simmesport and Melville.

Remarks.—The country from the head of the river to Melville (31 miles), on the right, is highly cultivated, with cotton as the principal crop, the plantation and tenant houses forming an almost continuous village along the inside of the levee. On the left bank the same conditions prevail for about 20 miles from the head of the river; after this point the country is only partially cleared. Below Melville no clearings are found on either bank, except abandoned plantations.

The navigation of the river by river steamboat is somewhat perilous at low water owing to the numerous snags, and at high water because of the treacherous eddies caused by projecting points and cave-ins; but ample water for steamboats is found at all times of the year over the reach surveyed.

Remains of the "Raft" are found, chiefly between Simmesport and Melville, most prominently at "The Ricketts" and "Delano Ricketts," where the navigable channel is very narrow, and the "Raft" remains are plainly visible at low water.

The weather and river stage were very favorable to the work.

Miles of river surveyed	69
Time occupied by survey proper in days	52
Rainy days and Sundays	8
Number of actual working days	44
Progress per working day in miles	1.5

The land slope of the left bank is given below in reaches. The increased slope from the head of Alabama Bayou to the foot of same, and the diminished slope from Melville to the Alabama Bayou, would seem to have been caused by the levee ending just above the Alabama Bayou and the consequent piling up of the water and increased deposit of alluvial matter.

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Slope of land surface per mile, with distance in miles from head of Atchafalaya River to Grand River.

	Distance.	Elevation of ground.	Slope.	Slope per mile.
		Feet.		*Feet.*
P. B. M. 92, Barbre Landing	0.00	47.90	0.00	0.000
P. B. M. 10, opposite Melville	30.00	28.80	19.10	.637
P. B. M. 15, opposite head Alabama Bayou	12.00	22.24	6.56	.547
Foot Alabama Bayou	13.45	13.12	9.12	.676
P. B. M. 24, opposite Butte La Rose	10.29	9.60	3.52	.342

Elevations are referred to mean Gulf level.

The rapid progress of the survey is due to the interest and industry displayed by my assistants, and the favorable conditions for the work.

Respectfully submitted.

W. G. COMBER, *Assistant Engineer.*

Capt. WM. B. LADUE,
Corps of Engineers, U. S. Army,
Secretary Mississippi River Commission.

APPENDIX 1 C.

REPORT OF JUNIOR ENGINEER E. L. HARMAN ON ADJUSTMENT OF PRECISE-LEVEL LOOP NORTH OF BRAINERD, MINN., VIA CASS LAKE, GRAND RAPIDS, AND AITKIN, MINN.

ST. LOUIS, MO., *June 2, 1905.*

CAPTAIN: I have the honor to submit the following report on the adjustment of the precise-level loop north of Brainerd, Minn.

The following lines, viz, Brainerd, Minn., to Grand Rapids, Minn. (Blackberry Station), via Cass Lake, Minn., 1900; Brainerd, Minn., to Aitkin, Minn., 1898; and Aitkin, Minn., to Grand Rapids, Minn. (Blackberry Station), 1902, form a closed loop.

It is desired to embrace all this work north of Brainerd, Minn., in one report, with rod corrections and loop adjustment all made.

The tabulated results have all been published, as follows:

(1) Brainerd, Minn., to Aitkin, Minn., 1898 (under head St. Paul, Minn., to Aitkin, Minn.). See Report of Chief of Engineers, 1899, Table No. 5, pages 3420 to 3468, the report on which and the descriptions of bench marks are given in same report, pages 3405 to 3419.

(2) Brainerd, Minn., to Grand Rapids, Minn. (Blackberry Station), via Cass Lake, Minn. (under the heads Brainerd, Minn., to Lake Itasca, Minn., 1900, and Cass Lake, Minn., to Grand Rapids, Minn, 1900). See Report of Chief of Engineers, 1901, Table No. 5, pages 72 to 111, the report on which is given in same report, pages 69 to 71, and the descriptions of the bench marks in same report, pages 112 to 125.

(3) Aitkin, Minn., to Grand Rapids, Minn. (Blackberry Station), 1902. See Report of Chief of Engineers, 1903, Table No. 3, pages 80 to 96, the report on which has never been published, but the route of the line and the descriptions of the bench marks are given in same report, pages 74 to 75 and 78 to 79.

Some items of a report will have to be mentioned here to properly lead up to the adjustment of the loop.

Methods of field work.—The methods pursued are those described in the Report of the Chief of Engineers for 1899, page 3469.

Instruments.—The instruments used were Kern precise level No. 4, Fauth bubble No. 214, and Kern precise-level rods Nos. XVIII and XIX. The rod supports for turning points were foot pins, except in a few instances, where footplates were used where we had stretches of hard, sandy road.

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The instrumental constants were determined at the beginning and at the end of the season, and are as follows:

Instrumental constants.

Instrument telescope.	Date of observation.	Inequality of collars, correction p in millimeters per meter.	Wire interval in millimeters per meter.
Kern No. 4	Mar. 27, 1902	−0.0064	4.26
Do	June 26, 1902	−.0050	4.25

Value of one division of bubble tube.

Bubble tube.	Date of observation.	Value in seconds of arc.	Value in millimeter per meter.
Fauth No. 214	Mar. 27, 1902	2.29	0.01109
Do	June 26, 1902	2.25	.01090

Value of correction "A" for rods is 55.9 mm. as determined June 6, 1900.

Lengths of rods.—In the office reduction the standard length of 1 meter on rods XVIII and XIX has been taken to be 1.000105 meters, this value being a mean of the lengths of the 3 meters on each rod as determined by comparison with the Repsold meter (R. 1876) on the United States Lake Survey Comparator on August 18, 1901, under the direction of Maj. W. L. Fisk, Corps of Engineers, U. S. Army, to whom these rods were loaned that summer. The resulting length of each meter, counting from the lower end of the rod in both instances, was—

Rod XVIII, first meter, 0.99984 meter, at temperature 23.4° C.
Rod XVIII, second meter, 1.00037 meters, at temperature 23.5° C.
Rod XVIII, third meter, 1.00010 meters, at temperature 23.6° C.
Rod XIX, first meter, 1.00005 meters, at temperature 23.2° C.
Rod XIX, second meter, 1.00023 meters, at temperature 23.3° C.
Rod XIX, third meter, 1.00004 meters, at temperature 23.3° C.

Mean value of 1 meter on rods is 1.000105 meters. Therefore the difference in elevation between bench marks will be numerically greater than that given by the rods by 0.105 millimeter per meter, and this is the rod correction applied on this stretch of work.

It will be observed that this is nearly the same as applied to the stretch St. Paul, Minn., to Aitkin., Minn., 1898, for the same rods, viz, −0.12 millimeter per meter (see Report of Chief of Engineers, 1899, p. 3407).

In view of the close agreement of the two values given above, it is decided (after consultation with W. S. Williams, who made the comparison in the office of the secretary, Mississippi River Commission, on April 9, 1901, and was present at the comparison made by the United States Lake Survey on August 18, 1901) to ignore the correction given April 9, 1901 (viz, −0.29 millimeter per meter), to the lines Brainerd, Minn., to Lake Itasca, Minn., and Cass Lake, Minn., to Grand Rapids, Minn. (Blackberry Station), 1900; and apply this last correction (viz, +0.105 millimeter per meter) to the said stretches given in Report of Chief of Engineers, 1901, Supplement, pages 72 to 111.

As to the lengths of meters on rods XI and XIV, which were used in conjunction with rods XVIII and XIX on the 1900 work, it will be seen by looking at the comparison given in Report of Chief of Engineers, 1901, page 70, that the length of meter on rods XI and XIV is only 0.02 millimeter shorter than 1 meter on rods XVIII and XIX. Hence we must agree that the rods are close to being identical in length.

Subsequent information has come to us as to the length of meters on rods XI and XIV, inasmuch as they were compared with the apparatus in the United States Lake Survey office in Detroit, Mich., in August, 1904, and the mean value of 1 meter was determined to be 1.0000064 meters. Now this is 0.3 millimeter per meter longer than given April 9, 1901, in office of Mississippi River Commission, and only 0.098

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millimeter per meter shorter than value given rods XVIII and XIX on August 18, 1901, in the comparison with Repsold meter (R. 1876) on the United States Lake Survey Comparator.

This last value for meters on rods XI and XIV simply fortifies us in applying the value for rods XVIII and XIX obtained August 18, 1901, to the entire line Brainerd, Minn., to Lake Itasca, Minn., and Cass Lake, Minn., to Grand Rapids, Minn. (Blackberry Station), 1900.

Adjustment of the loop.—Applying the rod corrections as mentioned above, we have a closure at temporary bench mark 230 H (Blackberry Station) of 45.5 millimeters, the length of the loop being 399.7 kilometers (=249.8 miles), or a closure of 0.114 millimeter per kilometer. This adjustment is made in the tabulations which follow (Table 3).

Respectfully submitted.

EUGENE L. HARMAN,
Junior Engineer.

Capt. WM. B. LADUE,
Corps of Engineers, U. S. Army,
Secretary Mississippi River Commission.

TABLE No. 2.

DESCRIPTION OF STONE-LINE BENCH MARKS FROM STONE LINE NO. 325, NEAR PINE KNOLL, MINN., TO STONE LINE NO. 328 AT AITKIN, MINN. (1,086 MILES ABOVE CAIRO), WITH ELEVATIONS IN FEET ABOVE MEMPHIS DATUM.

[Continued from Table No. 4, report of Chief of Engineers, 1900, page 4621. For geodetic positions see Report of Chief of Engineers, 1899, page 3399.
Elevations deduced from adjusted elevations of precise level lines north of Brainerd, Minn.]

Stone line 325.

[Three-fourths mile above sharp bend in river at Pine Knoll and about 2¼ miles below the mouth of Cedar Brook.]

$\frac{325}{1}$, P. B. M. Tile and pipe, on left bank, three-fourths mile above sharp bend at Pine Knoll; 300 meters above mouth of Wakefield Brook; on high ground, 75 meters back from river; 65 meters below Frank Dotsler's house. Elevation cap on pipe, 1,216.67 feet; bolt in tile, 1,212.70 feet.

$\frac{325}{2}$. Tile and pipe, on right bank, about 250 meters above mouth of Wakefield Brook, on high ground, 75 meters back from river, on lower bank of low open spot; 50 meters below a point opposite Frank Dotsler's house. Trees blazed facing bench mark. Elevation cap on pipe, 1,204 feet; bolt in tile, 1,200.02 feet.

Stone line 326.

[About 600 meters above Cedar Brook.]

$\frac{326}{1}$, P. B. M. Tile and pipe, on left bank, 600 meters above mouth of Cedar Brook, in cultivated field, 35 meters below junction of fences, 50 meters back from river, 100 meters above house on property belonging to D. McGillis's estate. Elevation cap on pipe, 1,208.78 feet; bolt in tile, 1,204.81 feet.

$\frac{326}{2}$. Tile and pipe, on right bank, opposite $\frac{326}{1}$, in timber, 50 meters back from river. Trees blazed facing bench marck. Elevation cap on pipe, 1,207.57 feet; bolt in tile, 1,203.61 feet.

Stone line 327.

[Three miles below Aitkin, Minn.]

$\frac{327}{1}$, P. B. M. Tile and pipe, on left bank, 3 miles below Aitkin, Minn., on property of Conrad Schwab, and about 50 meters southeast of his house; 75 meters back from river, 3 meters east of small ditch, 3 meters west of fence, in section 15. Blazed trees: 36-inch basswood, 39°, 23.1 meters; 8-inch basswood, 105°, 3.5 meters; 15-inch ash, 173°, 5.3 meters. Elevation cap on pipe, 1,209.22 feet; bolt in tile, 1,205.26 feet.

$\frac{327}{2}$. Tile and pipe, on right bank, 3 miles below Aitkin, Minn.; in timber, 20 meters back from river, about 50 meters above a point opposite Conrad Schwab's house. Elevation cap on pipe, 1,209,62 feet; bolt in tile (not leveled to).

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Stone line 328.

[At wagon bridge at Aitkin, Minn.]

$\frac{328}{1}$, P. B. M. Tile and pipe, on left bank, in Aitkin, Minn., in cultivated field, one-half meter west of fence on west side of street leading to wagon bridge over the Mississippi River, 11 meters south of fence corner on property of Hodgeden and McDonald, and about 75 meters back from river. Elevation cap on pipe, 1,209.04 feet; bolt in tile, 1,205.07 feet.

$\frac{328}{2}$. Tile and pipe, on right bank, on west side of wagon road leading to wagon bridge over the Mississippi River, 40 meters north from north end of bridge approach, one-half meter northwest of junction of fences, in Wm. Scriven's yard, 24.6 meters southeast of the southeast corner of his house. Elevation cap on pipe, 1,209.20 feet; bolt in tile, 1,205.21 feet.

TABLE No. 3.—*Elevations of precise-level bench marks north of Brainerd, Minn.*

BRAINERD TO CASS LAKE, 1900.

[For description of bench marks see Report of the Chief of Engineers for 1901, supplement, pages 112 to 120.]

Bench mark.	Rod correction.	Loop adjustment.	Elevation above Cairo datum.	
			Meters.	Feet.
	mm.	*mm.*		
ⓐ North base; bolt in tile (Brainerd)			378.1287	1,224.186
ⓐ North base; cap on pipe (Brainerd)	+0.1	0.0	374.3441	1,228.174
P. B. M. $\frac{328}{1}$; bolt in tile	+ .1	.0	373.6327	1,225.840
P. B. M. $\frac{328}{2}$; cap on pipe	+ .2	.0	374.8407	1,229.808
P. B. M. Merrifield; bolt in tile	+ .4	− 1.1	376.8967	1,236.549
P. B. M. Merrifield; cap on pipe	+ .5	− 1.1	378.1098	1,240.529
P. B. M. Pequot; bolt in tile	+2.4	− 3.5	395.7719	1,298.476
P. B. M. Pequot; cap on pipe	+2.5	− 8.5	396.9815	1,302.444
P. B. M. Pine River; bolt in tile	+2.9	− 5.2	400.9767	1,315.552
P. B. M. Pine River; cap on pipe	+3.1	− 5.2	402.1818	1,319.506
P. B. M. Backus; bolt in tile	+4.2	− 6.8	413.4471	1,356.466
P. B. M. Backus; cap on pipe	+4.4	− 6.8	414.6571	1,360.436
P. B. M. Hackensack; bolt in tile	+5.9	− 8.4	428.9034	1,407.176
P. B. M. Hackensack; cap on pipe	+6.0	− 8.4	430.1180	1,411.161
P. B. M. Portage Lake; bolt in tile	+5.9	− 9.6	429.8087	1,410.146
P. B. M. Portage Lake; cap on pipe	+6.1	− 9.6	431.0227	1,414.129
P. B. M. Walker; bolt in tile (Walker, Minn.)	+3.8	−10.8	408.9291	1,341.643
P. B. M. Walker; cap on pipe (Walker, Minn.)	+3.9	−10.8	410.1352	1,345.600
P. B. M. Cole	+3.7	−10.8	408.3804	1,339.843
P. B. M. Water tank (Walker, Minn.)	+4.9	−10.8	420.1169	1,378.349
P. B. M. Leech Lake; bolt in tile	+4.1	−11.8	412.3561	1,352.886
P. B. M. Leech Lake; cap on pipe	+4.2	−11.8	413.5609	1,356.839
P. B. M. Steamboat Lake; bolt in tile	+3.3	−13.3	404.1840	1,326.075
P. B. M. Steamboat Lake; cap on pipe	+3.4	−13.3	405.3909	1,330.034
T. B. M. 92	+4.2	−14.7	413.1351	1,355.442

CASS LAKE TO LAKE ITASCA, 1900.

[For description of bench marks see Report of the Chief of Engineers for 1901, supplement, pages 112 to 120.]

T. B. M. 92	+4.2	−14.7	413.1351	1,355.442
P. B. M. Wye; bolt in tile	+4.1	−14.7	412.0368	1,351.839
P. B. M. Wye; cap on pipe	+4.2	−14.7	413.2518	1,355.825
P. B. M. Midge Lake; bolt in tile	+4.0	−14.7	410.9330	1,348.218
P. B. M. Midge Lake; cap on pipe	+4.1	−14.7	412.1426	1,352.186
ⓐ Bemidji; bolt in tile	+5.1	−14.7	421.8475	1,383.370
ⓐ Bemidji; cap on pipe	+5.2	−14.7	422.8610	1,387.352
P. B. M. Willets; bolt in tile	+4.9	−14.7	420.2531	1,378.796
P. B. M. Willets; cap on pipe	+5.1	−14.7	421.4633	1,382.766
P. B. M. Bemidji tank	+5.1	−14.7	421.2973	1,382.221
P. B. M. Dorman; bolt in tile	+5.5	−14.7	425.4273	1,395.771
P. B. M. Dorman; cap on pipe	+5.6	−14.7	426.6389	1,399.746
P. B. M. Collette; bolt in tile	+5.1	−14.7	421.5217	1,382.958
P. B. M. Collette; cap on pipe	+5.2	−14.7	422.7357	1,386.940
ⓐ County line; bolt in tile	+8.5	−14.7	453.7556	1,488.713
ⓐ County line; cap on pipe	+8.6	−14.7	454.9717	1,492.703
P. B. M. Hennepin; bolt in tile	+5.7	−14.7	427.7840	1,403.508
P. B. M. Hennepin; cap on pipe	+5.9	−14.7	428.9965	1,407.481
P. B. M. Rapids; bolt in tile	+6.2	−14.7	432.0456	1,417.485
P. B. M. Rapids; cap on pipe	+6.3	−14.7	433.2559	1,421.456

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TABLE No. 3.—*Elevations of precise-level bench marks north of Brainerd, Minn.*—Cont'd.

CASS LAKE TO LAKE ITASCA, 1900—Continued.

Bench mark.	Rod correction.	Loop adjustment.	Elevation above Cairo datum.	
			Meters.	Feet.
	mm.	*mm.*		
P. B. M. La Salle; bolt in tile	+ 6.7	−14.7	437.3172	1,434.781
P. B. M. La Salle; cap on pipe	+ 6.9	−14.7	438.5290	1,438.756
(A) Prospect Hill; bolt in tile	+15.8	−14.7	518.4209	1,700.871
(A) Prospect Hill; cap on pipe	+15.4	−14.7	519.6381	1,704.865
P. B. M. Sherratt; bolt in tile	+ 9.1	−14.7	459.6699	1,508.117
P. B. M. Sherratt; cap on pipe	+ 9.2	−14.7	460.8886	1,512.115
P. B. M. Park line; bolt in tile	+ 8.9	−14.7	457.6957	1,501.640
P. B. M. Park line; cap on pipe	+ 9.0	−14.7	458.9075	1,505.616
(A) Itasca; bolt in tile	+10.5	−14.7	473.0268	1,551.939
(A) Itasca; cap on pipe	+10.6	−14.7	474.2425	1,555.928
P. B. M. Park House; bolt in tile	+ 9.1	−14.7	460.0493	1,509.362
P. B. M. Park House; cap on pipe	+ 9.3	−14.7	461.2611	1,513.337
4.2 foot mark on United States gauge, Lake Itasca	+ 8.5	−14.7	458.8511	1,489.026

CASS LAKE TO GRAND RAPIDS (BLACKBERRY STATION), 1900.

[For description of bench marks see Report of the Chief of Engineers for 1901, supplement, pages 120 to 125.]

T. B. M. 92	+4.2	−14.7	413.1351	.....
P. B. M. Round House (Cass Lake, Minn.)	+3.9	−14.9	410.1447	1,345.631
U. S. E. B. M. 347; bolt in stone	+4.0	−14.9	411.2866	1,349.378
U. S. E. B. M. 347; cap on pipe	+4.1	−14.9	412.4859	1,353.312
U. S. E. B. M. 342; bolt in stone	+3.6	−15.3	407.0947	1,335.694
U. S. E. B. M. 342; cap on pipe	+3.7	−15.3	408.2920	1,339.553
P. B. M. Lomond Spur; bolt in tile	+3.4	−15.6	405.3982	1,330.042
P. B. M. Lomond Spur; cap on pipe	+3.5	−15.6	406.6044	1,334.016
U. S. E. B. M. 337; cap on pipe	+3.3	−15.6	404.3498	1,326.619
(A) Bigosh; bolt in tile	+3.7	−18.1	408.0282	1,338.687
(A) Bigosh; cap on pipe	+3.8	−18.1	409.2428	1,342.672
(A) Bena; bolt in tile	+3.6	−18.2	407.6267	1,337.370
(A) Bena; cap on pipe	+3.7	−18.2	408.8392	1,341.348
(A) Norway Grove; bolt in tile	+3.8	−18.7	409.0078	1,341.901
(A) Norway Grove; cap on pipe	+3.9	−18.7	410.2157	1,345.864
(A) Divide; bolt in tile	+3.7	−20.0	408.6060	1,340.582
(A) Divide; cap on pipe	+3.8	−20.0	409.8106	1,344.535
B. M. Mississip; bolt in tile[a]	+3.2	−20.4	408.9971	1,341.862
B. M. Mississip; cap on pipe[a]	+3.4	−20.4	405.2048	1,329.422
U. S. E. B. M. 304; bolt in stone	+2.9	−20.5	400.4008	1,313.663
U. S. E. B. M. 304; cap on pipe	+3.0	−20.5	401.5971	1,317.598
B. M. Tomahawk; bolt in tile	+3.2	−20.7	403.2094	1,322.877
B. M. Tomahawk; cap on pipe	+3.3	−20.7	404.4126	1,326.825
B. M. Wigwam; bolt in tile	+2.7	−20.9	398.9767	1,308.990
B. M. Wigwam; cap on pipe	+2.8	−20.9	400.1915	1,312.976
(A) Starke; bolt in tile	+2.6	−21.2	397.9455	1,305.607
(A) Starke; cap on pipe	+2.7	−21.2	399.1586	1,309.587
(A) Old Road; bolt in tile	+2.8	−21.8	400.2648	1,313.217
(A) Old Road; cap on pipe	+3.0	−21.8	401.4734	1,317.182
(A) Deer River; bolt in tile	+3.0	−22.0	401.6703	1,317.828
(A) Deer River; cap on pipe	+3.1	−22.0	402.8902	1,321.830
B. M. Roundhouse; bolt in tile (Deer River, Minnesota)	+2.8	−22.0	399.4002	1,310.380
B. M. Roundhouse; cap on pipe (Deer River, Minnesota)	+2.9	−22.0	400.5987	1,314.312
U. S. E. B. M. 192; bolt in stone	+2.6	−22.1	397.6032	1,304.484
U. S. E. B. M. 192; cap on pipe	+2.7	−22.1	398.8005	1,308.412
5.6-foot mark on gage on R. R. bridge over Deer River	+2.5	−22.1	396.7061	1,301.541
B. M. Cohasset; bolt in tile	+2.4	−23.7	396.4229	1,300.612
B. M. Cohasset; cap on pipe	+2.6	−23.7	397.6317	1,304.578
U. S. E. B. M. 166; bolt in stone	+2.4	−23.7	395.8425	1,298.707
U. S. E. B. M. 166; cap on pipe	+2.5	−23.7	397.0875	1,302.628
B. M. Dam; bolt in tile	+2.7	−24.1	399.0327	1,309.174
B. M. Dam; cap on pipe	+2.8	−24.1	400.2441	1,313.149
Old U. S. B. M.	+2.4	−24.1	396.4145	1,300.584
P. B. M. Pokegama Falls	+2.7	−24.1	398.4708	1,307.329
U. S. E. B. M. 167; bolt in stone	+2.4	−24.1	396.0942	1,299.533
U. S. E. B. M. 167; cap on pipe	+2.5	−24.1	397.2939	1,303.469
XIV-foot mark on gage above Pokegama dam, right bank	+2.4	−24.1	396.2096	1,299.912
VIII-foot mark on gage below Pokegama dam, right bank	+2.2	−24.1	394.3787	1,293.905
VIII-foot mark on gage below Pokegama dam, left bank	+2.2	−24.1	394.3860	1,293.929
(A) Grand Rapids; bolt in tile	+2.4	−24.4	396.4128	1,297.298
(A) Grand Rapids; cap on pipe	+2.5	−24.4	396.6242	1,301.272
P. B. M. Balustrade	+2.7	−24.7	399.3649	1,310.264
(A) Race track; bolt in tile	+2.3	−24.7	395.4149	1,297.305

[a] B. M. Mississip was moved by railroad company in June, 1904; present elevation not determined.

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TABLE No. 3.—*Elevations of precise-level bench marks north of Brainerd, Minn.*—Cont'd.

CASS LAKE TO GRAND RAPIDS (BLACKBERRY STATION), 1900—Continued.

Bench mark.	Rod correction.	Loop adjustment.	Elevation above Cairo datum.	
			Meters.	Feet.
	mm.	mm.		
(A) Race track; cap on pipe	+2.5	−24.7	396.6255	1,301.276
B. M. Grand Rapids; bolt in tile	+2.5	−24.7	396.8272	1,301.938
B. M. Grand Rapids; cap on pipe	+2.6	−24.7	398.0379	1,305.910
P. B. M. Prairie River	+2.6	−25.1	397.4707	1,304.049
(A) LaPrairie; cap on pipe	+2.6	−25.2	397.4918	1,304.119
B. M. Blackberry; bolt in tile	+3.1	−25.8	402.3506	1,320.060
B. M. Blackberry; cap on pipe	+3.2	−25.8	403.5622	1,324.035
T. B. M. 230	+3.2	−25.8	403.1778	1,322.774

AITKIN TO GRAND RAPIDS (BLACKBERRY STATION), 1902.

[For description of bench marks see Report of the Chief of Engineers for 1903, supplement, pages 78 and 79.]

P. B. M. Court-house (Aitkin) [a]	0.0	+ 7.7	376.7758	1,236.152
P. B. M. $\frac{23}{0}$; bolt in tile [a]	− .5	+ 7.8	371.3035	1,218.198
P. B. M. $\frac{23}{0}$; cap on pipe [a]	− .4	+ 7.8	372.5147	1,222.172
(A) Lower base; bolt in tile [a]	− .5	+ 7.8	371.3678	1,218.408
(A) Lower base; cap on pipe [a]	− .4	+ 7.8	372.5811	1,222.390
B. M. $\frac{23}{0}$; bolt in tile [b]	− .5	+ 7.8	371.3472	1,218.342
B. M. $\frac{23}{0}$; cap on pipe [b]	− .4	+ 7.8	372.5612	1,222.325
U. S. E. B. M. 202; cap on pipe	− .3	+ 8.6	373.3044	1,224.763
P. B. M. Cut-off; bolt in tile	− .4	+ 8.7	372.2509	1,221.307
P. B. M. Cut-off; cap on pipe	− .3	+ 8.7	373.4684	1,225.301
P. B. M. Biggar; bolt in tile	− .4	+ 8.9	372.5256	1,222.208
P. B. M. Biggar; cap on pipe	− .3	+ 8.9	373.7395	1,226.190
P. B. M. Sutton; bolt in tile	− .3	+ 9.5	373.3717	1,224.984
P. B. M. Sutton; cap on pipe	− .2	+ 9.5	374.5911	1,228.984
U. S. E. B. M. 209; bolt in stone	− .3	+ 9.8	373.9498	1,226.880
U. S. E. B. M. 209; cap on pipe	− .2	+ 9.8	375.1551	1,230.835
P. B. M. Waldeck; bolt in tile	− .2	+ 9.9	374.2580	1,227.892
P. B. M. Waldeck; cap on pipe	− .2	+ 9.9	375.4696	1,231.867
P. B. M. Fowlds; bolt in tile	− .2	+10.6	374.5953	1,228.998
P. B. M. Fowlds; cap on pipe	− .1	+10.6	375.8117	1,232.989
P. B. M. Strand; bolt in tile	− .2	+11.0	375.1925	1,230.958
P. B. M. Strand; cap on pipe	.0	+11.0	376.4009	1,234.922
P. B. M. Carlson; bolt in tile	+ .3	+11.6	379.7242	1,245.825
P. B. M. Carlson; cap on pipe	+ .4	+11.6	380.9362	1,249.802
P. B. M. School; bolt in tile	+ .2	+12.2	378.8802	1,243.056
P. B. M. School; cap on pipe	+ .3	+12.2	380.0921	1,247.032
P. B. M. Pat; bolt in tile	.0	+12.7	377.2417	1,237.681
P. B. M. Pat; cap on pipe	+ .2	+12.7	378.4546	1,241.660
P. B. M. Sandy; bolt in tile	+ .1	+13.3	377.8484	1,239.671
P. B. M. Sandy; cap on pipe	+ .2	+13.3	379.0566	1,243.635
U. S. E. B. M	+ .1	+13.3	377.3781	1,238.128
P. B. M. Big Lagoon; bolt in tile	+ .3	+13.6	379.4059	1,244.781
P. B. M. Big Lagoon; cap on pipe	+ .4	+13.6	380.6248	1,248.780
P. B. M. Midway; bolt in tile	+ .8	+14.2	384.2948	1,260.821
P. B. M. Midway; cap on pipe	+ .9	+14.2	385.5156	1,264.826
P. B. M. Wells; bolt in tile	+ .6	+14.7	382.5829	1,255.040
P. B. M. Wells; cap on pipe	+ .7	+14.7	383.7440	1,259.014
P. B. M. Stone; bolt in tile	+ .6	+15.1	383.1946	1,257.211
P. B. M. Stone; cap on pipe	+ .8	+15.1	384.4082	1,261.198
P. B. M. Le Moon; bolt in tile	+ .8	+15.8	385.2787	1,264.049
P. B. M. Le Moon; cap on pipe	+1.0	+15.8	386.4915	1,268.028
P. B. M. Tiessen; bolt in tile	+1.1	+16.4	387.0149	1,269.745
P. B. M. Tiessen; cap on pipe	+1.2	+16.4	388.2302	1,273.732
P. B. M. Vicinity; bolt in tile	+1.3	+16.9	388.8788	1,275.860
P. B. M. Vicinity; cap on pipe	+1.4	+16.9	390.0899	1,279.834
P. B. M. Shep; bolt in tile	+1.3	+17.4	388.8325	1,275.709
P. B. M. Shep; cap on pipe	+1.4	+17.4	390.0446	1,279.685
P. B. M. Split Hand; bolt in tile	+1.6	+17.8	391.5153	1,284.510
P. B. M. Split Hand; cap on pipe	+1.7	+17.8	392.7829	1,288.505
P. B. M. Hamilton; bolt in tile	+1.7	+18.4	392.4222	1,287.486
P. B. M. Hamilton; cap on pipe	+1.8	+18.4	393.6376	1,291.473
P. B. M. Five Pines; bolt in tile	+2.1	+19.0	396.7172	1,301.577
P. B. M. Five Pines; cap on pipe	+2.2	+19.0	397.9307	1,305.559
P. B. M. Strawberry; bolt in tile	+2.6	+19.4	401.5911	1,317.568
P. B. M. Strawberry; cap on pipe	+2.7	+19.4	402.8063	1,321.555
T. B. M. 230	+2.7	+19.7	403.1778	1,322.774

[a] For description see Report of the Chief of Engineers for 1899, page 3419.
[b] For description see page 83 herewith.

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TABLE No. 3.—*Elevations of precise-level bench marks north of Brainerd, Minn.*—Cont'd.

CASS LAKE TO LAKE ITASCA, 1900—Continued.

Bench mark.	Rod correction.	Loop adjustment.	Elevation above Cairo datum.	
			Meters.	Feet.
	mm.	*mm.*		
P. B. M. La Salle; bolt in tile	+ 6.7	−14.7	437.3172	1,434.781
P. B. M. La Salle; cap on pipe	+ 6.9	−14.7	438.5290	1,438.756
(A) Prospect Hill; bolt in tile	+15.3	−14.7	518.4209	1,700.871
(A) Prospect Hill; cap on pipe	+15.4	−14.7	519.6381	1,704.865
P. B. M. Sherratt; bolt in tile	+ 9.1	−14.7	459.6699	1,508.117
P. B. M. Sherratt; cap on pipe	+ 9.2	−14.7	460.8886	1,512.115
P. B. M. Park line; bolt in tile	+ 8.9	−14.7	457.6957	1,501.640
P. B. M. Park line; cap on pipe	+ 9.0	−14.7	458.9075	1,505.616
(A) Itasca; bolt in tile	+10.5	−14.7	473.0268	1,551.939
(A) Itasca; cap on pipe	+10.6	−14.7	474.2425	1,555.928
P. B. M. Park House; bolt in tile	+ 9.1	−14.7	460.0493	1,509.362
P. B. M. Park House; cap on pipe	+ 9.3	−14.7	461.2611	1,513.337
4.2 foot mark on United States gauge, Lake Itasca	+ 8.5	−14.7	458.8511	1,489.026

CASS LAKE TO GRAND RAPIDS (BLACKBERRY STATION), 1900.

[For description of bench marks see Report of the Chief of Engineers for 1901, supplement, pages 120 to 125.]

T. B. M. 92	+4.2	−14.7	413.1351	.....
P. B. M. Round House (Cass Lake, Minn.)	+3.9	−14.9	410.1447	1,345.631
U. S. E. B. M. 347; bolt in stone	+4.0	−14.9	411.2866	1,349.378
U. S. E. B. M. 347; cap on pipe	+4.1	−14.9	412.4859	1,353.312
U. S. E. B. M. 342; bolt in stone	+3.6	−15.3	407.0947	1,335.624
U. S. E. B. M. 342; cap on pipe	+3.7	−15.3	408.2920	1,339.553
P. B. M. Lomond Spur; bolt in tile	+3.4	−15.6	405.3952	1,330.042
P. B. M. Lomond Spur; cap on pipe	+3.5	−15.6	406.6044	1,334.016
U. S. E. B. M. 337; cap on pipe	+3.3	−15.6	404.8498	1,326.619
(A) Bigosh; bolt in tile	+3.7	−18.1	408.0282	1,338.687
(A) Bigosh; cap on pipe	+3.8	−18.1	409.2428	1,342.672
(A) Bena; bolt in tile	+3.6	−18.2	407.6267	1,337.370
(A) Bena; cap on pipe	+3.7	−18.2	408.8392	1,341.348
(A) Norway Grove; bolt in tile	+3.8	−18.7	409.0078	1,341.901
(A) Norway Grove; cap on pipe	+3.9	−18.7	410.2157	1,345.864
(A) Divide; bolt in tile	+3.7	−20.0	408.6060	1,340.583
(A) Divide; cap on pipe	+3.8	−20.0	409.8106	1,344.535
B. M. Mississip; bolt in tile[a]	+3.2	−20.4	408.9971	1,325.462
B. M. Mississip; cap on pipe[a]	+3.4	−20.4	405.2043	1,329.422
U. S. E. B. M. 304; bolt in stone	+2.9	−20.5	400.4008	1,313.653
U. S. E. B. M. 304; cap on pipe	+3.0	−20.5	401.5971	1,317.588
B. M. Tomahawk; bolt in tile	+3.2	−20.7	403.2094	1,322.877
B. M. Tomahawk; cap on pipe	+3.3	−20.7	404.4126	1,326.825
B. M. Wigwam; bolt in tile	+2.7	−20.9	398.9767	1,308.990
B. M. Wigwam; cap on pipe	+2.8	−20.9	400.1915	1,312.976
(A) Starke; bolt in tile	+2.6	−21.2	397.9455	1,305.607
(A) Starke; cap on pipe	+2.7	−21.2	399.1586	1,309.587
(A) Old Road; bolt in tile	+2.8	−21.8	400.2648	1,313.217
(A) Old Road; cap on pipe	+3.0	−21.8	401.4734	1,317.182
(A) Deer River; bolt in tile	+3.0	−22.0	401.6708	1,317.828
(A) Deer River; cap on pipe	+3.1	−22.0	402.8902	1,321.830
B. M. Roundhouse; bolt in tile (Deer River, Minnesota)	+2.8	−22.0	399.4002	1,310.380
B. M. Roundhouse; cap on pipe (Deer River, Minnesota)	+2.9	−22.0	400.5967	1,314.312
U. S. E. B. M. 192; bolt in stone	+2.6	−22.1	397.6032	1,304.494
U. S. E. B. M. 192; cap on pipe	+2.7	−22.1	398.8005	1,308.412
5.6-foot mark on gage on R. R. bridge over Deer River	+2.5	−22.1	396.7061	1,301.541
B. M. Cohasset; bolt in tile	+2.4	−23.7	396.4229	1,300.612
B. M. Cohasset; cap on pipe	+2.6	−23.7	397.6317	1,304.578
U. S. E. B. M. 166; bolt in stone	+2.4	−23.7	395.8425	1,298.707
U. S. E. B. M. 166; cap on pipe	+2.5	−23.7	397.0375	1,302.628
B. M. Dam; bolt in tile	+2.7	−24.1	399.0327	1,309.174
B. M. Dam; cap on pipe	+2.8	−24.1	400.2441	1,313.149
Old U. S. B. M	+2.4	−24.1	396.4145	1,300.584
P. B. M. Pokegama Falls	+2.7	−24.1	398.4708	1,307.329
U. S. E. B. M. 167; bolt in stone	+2.4	−24.1	396.0942	1,299.533
U. S. E. B. M. 167; cap on pipe	+2.5	−24.1	397.2939	1,303.469
XIV-foot mark on gage above Pokegama dam, right bank	+2.4	−24.1	396.2096	1,299.912
VIII-foot mark on gage below Pokegama dam, right bank	+2.2	−24.1	394.3787	1,293.905
VIII-foot mark on gage below Pokegama dam, left bank	+2.2	−24.1	394.3860	1,293.929
(A) Grand Rapids; bolt in tile	+2.4	−24.4	395.4128	1,297.298
(A) Grand Rapids; cap on pipe	+2.5	−24.4	396.6242	1,301.272
P. B. M. Balustrade	+2.7	−24.7	399.3649	1,310.264
(A) Race track; bolt in tile	+2.3	−24.7	395.4149	1,297.305

[a] B. M. Mississip was moved by railroad company in June, 1904; present elevation not determined.

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TABLE No. 3.—*Elevations of precise-level bench marks north of Brainerd, Minn.*—Cont'd.

CASS LAKE TO GRAND RAPIDS (BLACKBERRY STATION), 1900—Continued.

Bench mark.	Rod correction.	Loop adjustment.	Elevation above Cairo datum.	
			Meters.	Feet.
	mm.	mm.		
(A) Race track; cap on pipe	+2.5	−24.7	396.6255	1,301.276
B. M. Grand Rapids; bolt in tile	+2.5	−24.7	396.8272	1,301.938
B. M. Grand Rapids; cap on pipe	+2.6	−24.7	398.0379	1,305.910
P. B. M. Prairie River	+2.6	−25.1	397.4707	1,304.049
(A) LaPrairie; cap on pipe	+2.6	−25.2	397.4918	1,304.119
B. M. Blackberry; bolt in tile	+3.1	−25.8	402.3506	1,320.060
B. M. Blackberry; cap on pipe	+3.2	−25.8	403.5622	1,324.035
T. B. M. 230	+3.2	−25.8	403.1778	1,322.774

AITKIN TO GRAND RAPIDS (BLACKBERRY STATION), 1902.

[For description of bench marks see Report of the Chief of Engineers for 1903, supplement, pages 78 and 79.]

P. B. M. Court-house (Aitkin) [a]	0.0	+ 7.7	376.7758	1,236.152
P. B. M. $\frac{21}{8}$; bolt in tile [a]	− .5	+ 7.8	371.3035	1,218.198
P. B. M. $\frac{21}{8}$; cap on pipe [a]	− .4	+ 7.8	372.5147	1,222.172
(A) Lower base; bolt in tile [a]	− .5	+ 7.8	371.3678	1,218.408
(A) Lower base; cap on pipe [a]	− .4	+ 7.8	372.5811	1,222.390
B. M. $\frac{21}{8}$; bolt in tile [b]	− .5	+ 7.8	371.3472	1,218.342
B. M. $\frac{21}{8}$; cap on pipe [b]	− .4	+ 7.8	372.5612	1,222.325
U. S. E. B. M. 202; cap on pipe	− .3	+ 8.6	373.3044	1,224.763
P. B. M. Cut-off; bolt in tile	− .4	+ 8.7	372.2509	1,221.307
P. B. M. Cut-off; cap on pipe	− .3	+ 8.7	373.4684	1,225.301
P. B. M. Biggar; bolt in tile	− .4	+ 8.9	372.5256	1,222.208
P. B. M. Biggar; cap on pipe	− .3	+ 8.9	373.7395	1,226.190
P. B. M. Sutton; bolt in tile	− .3	+ 9.5	373.3717	1,224.984
P. B. M. Sutton; cap on pipe	− .2	+ 9.5	374.5911	1,228.984
U. S. E. B. M. 209; bolt in stone	− .3	+ 9.8	373.9498	1,226.880
U. S. E. B. M. 209; cap on pipe	− .2	+ 9.8	375.1551	1,230.835
P. B. M. Waldeck; bolt in tile	− .2	+ 9.9	374.2580	1,227.892
P. B. M. Waldeck; cap on pipe	− .2	+ 9.9	375.4696	1,231.867
P. B. M. Fowlds; bolt in tile	− .2	+10.6	374.5953	1,228.998
P. B. M. Fowlds; cap on pipe	− .1	+10.6	375.8117	1,232.989
P. B. M. Strand; bolt in tile	− .2	+11.0	375.1925	1,230.958
P. B. M. Strand; cap on pipe	.0	+11.0	376.4009	1,234.922
P. B. M. Carlson; bolt in tile	+ .3	+11.6	379.7242	1,245.825
P. B. M. Carlson; cap on pipe	+ .4	+11.6	380.9362	1,249.802
P. B. M. School; bolt in tile	+ .2	+12.2	378.8802	1,243.056
P. B. M. School; cap on pipe	+ .3	+12.2	380.0921	1,247.032
P. B. M. Pat; bolt in tile	.0	+12.7	377.2417	1,237.681
P. B. M. Pat; cap on pipe	+ .2	+12.7	378.4546	1,241.660
P. B. M. Sandy; bolt in tile	+ .1	+13.3	377.8484	1,239.671
P. B. M. Sandy; cap on pipe	+ .2	+13.3	379.0566	1,243.635
U. S. E. B. M.	+ .1	+13.3	377.3781	1,238.128
P. B. M. Big Lagoon; bolt in tile	+ .3	+13.6	379.4059	1,244.781
P. B. M. Big Lagoon; cap on pipe	+ .4	+13.6	380.6248	1,248.780
P. B. M. Midway; bolt in tile	+ .8	+14.2	384.2948	1,260.821
P. B. M. Midway; cap on pipe	+ .9	+14.2	385.5156	1,264.826
P. B. M. Wells; bolt in tile	+ .6	+14.7	382.5829	1,255.040
P. B. M. Wells; cap on pipe	+ .7	+14.7	383.7440	1,259.014
P. B. M. Stone; bolt in tile	+ .6	+15.1	383.1946	1,257.211
P. B. M. Stone; cap on pipe	+ .8	+15.1	384.4082	1,261.198
P. B. M. Le Moon; bolt in tile	+ .8	+15.8	385.2787	1,264.049
P. B. M. Le Moon; cap on pipe	+1.0	+15.8	386.4915	1,268.028
P. B. M. Tiessen; bolt in tile	+1.1	+16.4	387.0149	1,269.745
P. B. M. Tiessen; cap on pipe	+1.2	+16.4	388.2302	1,273.732
P. B. M. Vicinity; bolt in tile	+1.3	+16.9	388.8788	1,275.860
P. B. M. Vicinity; cap on pipe	+1.4	+16.9	390.0899	1,279.834
P. B. M. Shep; bolt in tile	+1.3	+17.4	388.8325	1,275.709
P. B. M. Shep; cap on pipe	+1.4	+17.4	390.0446	1,279.685
P. B. M. Split Hand; bolt in tile	+1.6	+17.8	391.5153	1,284.510
P. B. M. Split Hand; cap on pipe	+1.7	+17.8	392.7329	1,288.505
P. B. M. Hamilton; bolt in tile	+1.7	+18.4	392.4222	1,287.486
P. B. M. Hamilton; cap on pipe	+1.8	+18.4	393.6376	1,291.473
P. B. M. Five Pines; bolt in tile	+2.1	+19.0	396.7172	1,301.577
P. B. M. Five Pines; cap on pipe	+2.2	+19.0	397.9307	1,305.559
P. B. M. Strawberry; bolt in tile	+2.6	+19.4	401.5911	1,317.568
P. B. M. Strawberry; cap on pipe	+2.7	+19.4	402.8063	1,321.555
T. B. M. 230	+2.7	+19.7	403.1778	1,322.774

[a] For description see Report of the Chief of Engineers for 1899, page 3419.
[b] For description see page 83 herewith.

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TABLE No. 3.—*Elevations of precise-level bench marks north of Brainerd, Minn.*—Cont'd.

BRAINERD TO AITKIN, 1898.

[For description of bench marks see Report of the Chief of Engineers for 1899, pages 3417 to 3419.]

Bench mark.	Rod correction.	Loop adjustment.	Elevation above Cairo datum.	
			Meters.	Feet.
	mm.	*mm.*		
ⓐ North base; bolt in tile (Brainerd)	+17.9	0.0	373.1287	1,224.186
ⓐ North base; cap on pipe (Brainerd)	+18.1	.0	374.3441	1,228.174
P. B. M. 2[16]; bolt in tile	+18.3	+ .4	376.7290	1,235.998
P. B. M. 2[16]; cap on pipe	+18.5	+ .4	377.9428	1,239.979
P. B. M. 2[17]; bolt in tile	+18.1	+2.2	374.6499	1,229.177
P. B. M. 2[17]; cap on pipe	+18.2	+2.2	375.8657	1,233.133
P. B. M. 2[18]; bolt in tile	+19.2	+2.8	384.0644	1,260.065
P. B. M. 2[18]; cap on pipe	+19.4	+2.8	385.2713	1,264.025
P. B. M. 2[19]; bolt in tile	+17.0	+3.3	365.5392	1,199.287
P. B. M. 2[19]; cap on pipe	+17.1	+3.3	366.7479	1,203.252
P. B. M. 2[20]; bolt in tile	+17.6	+3.9	370.6447	1,216.037
P. B. M. 2[20]; cap on pipe	+17.8	+3.9	371.8543	1,220.005
P. B. M. 2[21]; bolt in tile	+17.4	+4.3	368.5474	1,209.156
P. B. M. 2[21]; cap on pipe	+17.5	+4.3	369.7513	1,213.106
P. B. M. 2[22]; bolt in tile	+17.6	+4.8	370.3335	1,215.016
P. B. M. 2[22]; cap on pipe	+17.7	+4.8	371.5444	1,218.989
P. B. M. 2[23]; bolt in tile	+18.0	+5.5	373.8324	1,226.495
P. B. M. 2[23]; cap on pipe	+18.1	+5.5	375.0438	1,230.470
P. B. M. 2[24]; bolt in tile	+18.2	+6.1	375.4658	1,231.854
P. B. M. 2[24]; cap on pipe	+18.3	+6.1	376.6760	1,235.825
P. B. M. 2[25]; bolt in tile	+18.0	+6.6	373.6302	1,225.832
P. B. M. 2[25]; cap on pipe	+18.1	+6.6	374.8395	1,229.800
P. B. M. 2[26]; bolt in tile	+17.7	+6.9	371.2242	1,217.938
P. B. M. 2[26]; cap on pipe	+17.8	+6.9	372.4351	1,221.911
P. B. M. 2[27]; bolt in tile	+17.7	+7.2	371.3624	1,218.392
P. B. M. 2[27]; cap on pipe	+17.8	+7.2	372.5685	1,222.349
P. B. M. court-house (Aitkin)	+18.3	+7.7	376.7758	1,236.152

APPENDIX 1 D.

REPORT OF KIVAS TULLY, ASSISTANT ENGINEER, ON GAUGES, REDUCTION OF PHYSICAL DATA AND OFFICE PUBLICATIONS.

ST. LOUIS, MO., *May 31, 1905.*

CAPTAIN: I have the honor to submit the following report upon the work pertaining to gauges, discharge observations, and office publications from June 1, 1904, to May 31, 1905:

GAUGES.

The gauges in charge of this office comprise 37 regular gauges on the Mississippi River from St. Louis, Mo., to Fort Jackson, La., and its principal tributaries. These gauges are read twice daily. The highest and lowest readings on each of them during the year 1904 will be found in Table No. 4. The highest and lowest readings for each year from 1898 to date are also given in Table No. 5. This table is in extension of that published in Report of Chief of Engineers for 1898, pages 3250 to 3276.

Twenty-one of these gauges were received by transfer from the United States Engineer Office at Vicksburg, Miss., in 1901; the others were established by this office. A gauge established at Aitkin, Minn., for use during the general survey of the river in that vicinity was discontinued on June 30, 1904.

In addition to the regular gauges there are maintained 185 high-water gauges distributed about 5 miles apart on the main river from Head of the Passes to Cairo. These are read only at times of extreme high water.

Two self-registering tide gauges are maintained on the Gulf of Mexico, one at East Bay, La., and one at Biloxi, Miss.

A detailed description of these gauges will be found in the Supplement to the Report of the Chief of Engineers for 1902, pages 52 to 59. The number and location of stations are the same, with the exception that the gauge at Belmont, Mo., was moved across the Mississippi River to Columbus, Ky., where it has since been maintained. Minor changes and renewals made in the various gauges have been recorded in the Supplements for 1903 and 1904, pages 97 and 63, respectively.

At the date of the last annual report the gauge inspection party, in charge of Mr. E. L. Harman, junior engineer, on the steamer *Mars*, was above New Madrid on the

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way up the river. The high-water gauges 178 to 182 and the regular gauges at Columbus, Ky., and Cairo, Ill., were inspected by June 2, 1904, and the party, after establishing range stations for a new discharge section at Thebes, Ill., 45 miles above Cairo, returned to the fleet at West Memphis and was disbanded on June 9.

The regular gauges between Memphis and St. Louis were inspected by a party in charge of Mr. E. E. Whitehead on the upstream trip of the steamer *Mississippi*, October 24 to 31. Material for the reconstruction of the regular gauge at Cape Girardeau, Mo., was also brought up on this trip and left at that station.

The regular low-water inspection of all the gauges between Memphis and Cairo was begun by Junior Engineer E. L. Harman on the steamer *Patrol* on November 16, but on reaching Fulton, Tenn., the outfit was transferred to other work and the inspection was taken up by Mr. A. V. B. Candler on the steamer *Vulcan* December 18 and completed early in January.

All the regular gauges from Mhoon Landing, Miss., to Carrollton, La., were inspected from November 8 to December 6 by a party in charge of Junior Engineer Geo. H. Wolbrecht on the steamer *Mars*.

After making discharge observations at Carrollton, La., and rebuilding the tide-gauge house and approach at East Bay, La., this party resumed the gauge inspection early in January and inspected the Fort Jackson, La., gauge and the high-water gauges from the Head of the Passes to Memphis, revisiting also the regular gauges above Fort Jackson. Heavy running ice in the river rendered progress slow on the return trip, and the boat was tied up four days at Greenville, Miss., on this account. Memphis was reached about February 20 and the boat laid up at the fleet.

The regular gauges on the Tennessee, St. Francis, White, Arkansas, and Red rivers were inspected from November 1 to 13 by Assistant Engineer George H. French. The gauges at Louisville, Ky., were inspected in June, and the gauges at Nashville, Tenn., and Cape Girardeau, Mo., were reconstructed and will be referred to again in detail.

The high-water inspection of the regular gauges is now in progress.

The gauges were generally maintained in good order by means of the semiannual inspections, and except in a very few cases the errors found by leveling were less than one-tenth of a foot. In a few cases, as at Mhoon Landing and Sunflower Landing, where the unstable nature of the river banks caused considerable disturbances of the gauges, special inspections were promptly made, the gauges reset correctly, and the corrections for the records carefully determined.

The following gauges were reconstructed:

Nashville, Tenn. (U. S. engineer gauge, Cumberland River).—This was one of the United States engineer gauges transferred to this office in 1901. The old gauge at this station had been in use about thirty years. The main section was of the inclined type, of timber, with an iron strip for the graduations. The timbers were of red cedar, but were much decayed, and on the iron strip were cut two sets of graduations, which rendered correct reading difficult. It was therefore decided to rebuild the gauge. This was done under contract, the portions from 5.4 to 56 feet being rebuilt in June, and the portion from 5.4 to 1.3 feet in August.

In the latter part of October the new dam about 3 miles below Nashville was closed, and the pool apparently stands about 6½ feet on the gauge.

As reconstructed, the gauge is now as follows:

The gauge is at the foot of Broad street. The main section is inclined and follows the slope of the levee. It consists of a 6 by 6 inch red-cedar stringer, on top of which is bolted a strip of iron 4 inches wide and § inch thick. The stringer is embedded in the levee and rests on crosspieces of the same timber 4 feet long set in the ground every 6 feet. A narrow strip of the levee on either side of the gauge is paved with stone. This section reads from zero to 46.3 feet. The new portion, from 1½ to 46.3 feet, is 256 feet long. Temporary graduations were cut in a wood strip alongside the iron; the permanent graduations will be cut in the iron at next low water, after allowing due time for any slight settlement. The upper sections are vertical and comprise an iron strip § by 4 inches, graduated from 50.7 to 56 feet, bolted to southeast pilaster of Temperance Hall, north side of Broad street, near the corner of Front street, and two wooden boards, one, reading from 41 to 52 feet, nailed to a 6 by 8 inch cedar post on the levee opposite the 34-foot mark of the inclined gauge, and the other, reading from 48.1 to 54 feet, spiked to a telephone pole at top of levee. The gauge was set from B. M 1 (Merrill), which is 51.98 feet above zero of gauge.

Cape Girardeau, Mo. (Mississippi River Commission gauge, Mississippi River).—A new inclined gauge was built in the paved levee in the early part of December. This section consists of an 8 by 10 inch wood stringer with an iron strip 4 inches by § inch bolted on top and sunk flush with top of levee paving. The stringer rests on timber bents set 8 feet apart and extending about 4 feet below surface of levee. The lower end of stringer is bolted down to the natural rock. The timber is all yellow

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pine and was thoroughly swabbed with carbolineum. The inclined section is a little south of the south line of Themis street, produced, and parallel therewith. Temporary graduations were cut in a wooden strip nailed alongside the iron and read from 7 to 31.5 feet. Two vertical sections of wood are at the former gauge site at the foot of Independence street about 2 blocks below the inclined gauge, and read from 5 to 9 feet and from 26 to 36 feet, respectively. The new gauge was set from permanent bench mark 54, which is 41.67 feet above the zero.

Memphis, Tenn. (U. S. engineer gauge).—The new concrete-steel gauge constructed at the foot of Beal street, built in December, 1903, was extended down to the 2-foot mark in December, 1904. It is intended to connect the various bench marks of this gauge by precise levels this season, as the ordinary level lines show a disagreement of about 0.05 foot.

The gauge bulletin frames and figured plates, used for displaying the river stage to passing boats, were repaired and repainted at gauge inspections. Some of these are nearly worn out, and such are being replaced with those of the latest type, shown on plate 3, supplement to Report of Chief of Engineers, 1903. New bulletins of this type were put up during the year at New Madrid, Mo., Cottonwood Point, Mo., Fulton, Tenn., mouth of White River, Ark., Lake Providence, La., Natchez, Miss., and Carrollton, La.

The highest and lowest gauge readings of the year 1904 at all stations on the Mississippi River and its tributaries are given in Table No. 4. It will be noticed in this table that in only two cases are the records of former years surpassed, namely, at Peoria, on the Illinois River, where the high water of March 28–29, 1904, was 1.1 feet higher than before recorded, and at Johnsonville, Tenn., on the Tennessee River, where the low water of October 26 to November 4 was 0.6 foot lower than before recorded.

Table No. 5 gives the annual highest and lowest gauge readings for stations on the Mississippi River and tributaries from 1898 to July, 1905, inclusive, and is in continuation of Table No. 9, printed on pages 3250 to 3276, Report of Chief of Engineers for 1898. At many stations on the main river the highest water has occurred since that table was published. The previous highest and lowest are given where they have not been surpassed since 1898.

Hydrographs of the regular gauges, Cairo to Fort Jackson, from June 1, 1904, to May 31, 1905, are given on plate 1.

The tide gauges at Biloxi, Miss., and East Bay, La., have been maintained during the year. The staff gauges and their bench marks were connected by precise leveling in February, 1905. The gauge house and plank walk at East Bay were rebuilt in January, 1905. Owing to the demands of field work but little time was available for the reduction of the records during the year, but this work is now in progress.

DISCHARGE OBSERVATIONS.

All the discharge observations made under the Mississippi River Commission during the year 1904 have been reduced; the results will be found in Table No. 6.

The high-water measurements, which were all made at about the crest of the flood, were at eight stations on the Mississippi River from Thebes, Ill., to Carrollton, La., and at one station on the Atchafalaya and at one on the Arkansas River.

The low-water discharge was measured at only one place on the Mississippi River (Carrollton, La.), and at one place on the Atchafalaya (Neita, La.) The results give the lowest discharge of record at each place.

The discharge observations were made and reduced in the usual manner, except that at all stations below Cairo throughout a large part of the work two meters were used simultaneously, suspended on the same cable and about 2½ feet apart in the vertical. Each meter gave an independent velocity record, and a complete discharge was computed for each meter. This only slightly increased the work of computation, as the same partial areas were used for both meters.

This method of measuring discharge had been tried before by this office in an experimental way at comparatively low stages; the results, however, indicated that it was an improvement in meter work, and as this was the first time it was employed during high water, the following additional information may be of interest.

The observations at Columbus, Chicot, Red River Landing, and Simmesport were all made by the same party using Price meter No. 34 and Haskell meter, wheel No. 1/1. With the exception of two days the two meters gave almost the same discharges, the difference on April 13 at Chicot, Ark., being only 204 cubic feet per second. The velocities in feet per second at each station on the cross section for this day were as follows:

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Station, L. B.	Haskell, No. 1/1.	Price No. 34.	Station, L. B.	Haskell, No. 1/1.	Price No. 34.	Station, L. B.	Haskell, No. 1/1.	Price No. 34.
1	1.50	1.65	8	5.88	5.80	15	7.56	7.61
2	3.45	3.31	9	5.92	5.97	16	7.71	7.95
3	5.66	5.47	10	6.17	6.13	17	7.62	7.62
4	7.76	7.75	11	5.79	5.73			
5	3.20	3.44	12	5.81	5.84	Mean	5.726	5.722
6	4.50	4.17	13	6.45	6.53			
7	5.29	5.09	14	7.07	7.21			

It will be noticed in the above table that the greatest difference is 0.33 foot at station 6, the difference of the means being only 0.004 foot per second.

The only days on which these meters differed materially were the last day at Columbus, April 7, and the first day at Chicot, April 11, the differences being 0.57 foot and 0.32 foot per second, respectively; the Haskell meter gave the lower velocity in both cases.

It seems probable that something may have interfered with one or both of the meters on these days, and that later, in handling the meters, the cause was unknowingly removed. The observer could not account for the discrepancies referred to.

The mean of the results of the two meters is given in every case where these two meters were used.

The discharge party at Helena, Ark., and Carrollton, La., used Price meter No. 22 and Haskell meter, wheel No. 11. At Helena, except on the last day, these two meters gave widely different results; on the last day, and afterwards at Carrollton, the differences were very much smaller, indicating some change in the meters. The following table shows the velocities obtained in feet per second at each station across the river on April 10, in the period when the difference was greatest, the means differing 0.42 foot per second.

Station.	Haskell No. 11.	Price No. 22.	Station.	Haskell No. 11.	Price No. 22.	Station.	Haskell No. 11.	Price No. 22.
1	4.41	4.35	7	[a] 4.87	4.60	13	2.90	[a] 3.02
2	8.80	7.95	8	4.59	4.26	14	[a] 2.63	[a] 1.78
3	9.54	8.68	9	[a] 4.83	[a] 3.65	15	[a] 2.26	3.00
4	10.01	9.19	10	3.39	3.44			
5	8.90	8.17	11	[a] 3.66	3.27	Mean	5.325	4.899
6	6.26	5.77	12	[a] 2.92	2.36			

[a] Registrations not complete for the full five minutes' run.

The largest difference is at station 9, where the Haskell meter velocity seems excessive. On April 15, the last day, the mean difference was only 0.16 foot per second

At Carrollton, where these two meters were next used, the means differed on April 29, 0.13, and on May 3, 0.18, in feet per second.

The discharges given in the tables for Helena and Carrollton, for days on which these meters were used simultaneously, were obtained by combining the results of both meters, giving double weight to the Price meter and taking the mean.

The results of the season's work seem to fully justify the use of two meters in the manner described, and it is thought that in future work any material change of rate may be detected in the field and the trouble corrected at the time, or data obtained for computing the proper correction later. When only one meter is used, as was the case in earlier years, there is no check on its results except the approximate one of comparison with the float observations.

All the meters used were rated in the field at the close of the discharge work, and were again rated in August at the settling basins of the St. Louis waterworks at Bissells Point. All the rating observations have been reduced in the office by the method of least squares. The resulting values of the meter constants and the probable errors are given in Table No. 7.

The meters were mainly rated four at a time, two meters on each side of a skiff. The meter pairs were the same as used in the discharge work.

The meters during discharge work were run generally for five minutes at each velocity station and at six-tenths depth. At Thebes, however, the meter was run at a constant depth, mainly of 15 feet, and for four minutes.

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The observed velocities at Thebes were corrected to the mean of the vertical by the factors in the following table, which have been in use heretofore for stations where no special curves have been determined.

Proportional depth.	Factor.	Proportional depth.	Factor.	Proportional depth.	Factor.
Surface	0.9556	4/10	0.9849	8/10	1.0930
1/10	.9136	5/10	.9550	9/10	1.1959
2/10	.9154	6/10	.9897	Bottom	1.3847
3/10	.9270	7/10	1.0295		

The following table gives the maximum discharge at each high-water station of 1904; also the minimum low-water discharge at Carrollton and on the Atchafalaya. The previous highest and lowest discharges are given for comparison.

Discharge.

MISSISSIPPI RIVER.

Station.	Date.	1904.		Previous record.			Difference.[a]
		Gauge.	Discharge.[a]	Year.	Gauge.	Discharge.[a]	
	1904.	*Feet.*			*Feet.*		
Thebes, Ill	May 1	32.3	805	1903	34.6	1,014	−209
Columbus, Ky	Apr. 5	43.9	1,502	1882	43.6	1,603	−101
Memphis, Tenn	Apr. 9	38.6	1,618	1890	35.5	1,345	+273
Helena, Ark	Apr. 14	47.6	1,412	1903	50.9	1,686	−274
Chicot, Ark	Apr. 20	49.0	1,403	1903	50.4	1,743	−340
Vicksburg, Miss	Apr. 23	46.6	1,382	1897	52.0	1,777	−395
Red River Landing, La	Apr. 29	43.7	1,018	1882	48.3	1,595	−577
Red River Landing, including Simmesport			1,259	1890	47.2	1,926	−667
Carrollton, La	Apr. 24	15.8	1,098	1897	18.6	1,353	−255
Do	Dec. 30	.2	158	1895	1.6	191	− 33

ARKANSAS RIVER.

Little Rock, Ark	June 10	29.2	428	1892	30.0	457	.....
				1898	29.3	677	.....

ATCHAFALAYA RIVER.

Simmesport, La	Apr. 28	40.9	241	1890	48.0	480	−239
Neita, La	Dec. 23	.6	11	1891	− .6	12	− 1

[a] In thousand cubic feet per second.

Referring to the high water of 1904, it will be seen from the above table that the maximum discharge per second has a tendency to decrease as the flood passes down the river. Comparing Helena and Chicot, while the discharge at the lower station is only slightly less, an increase might have been expected since the White River was at a moderately high stage and was probably discharging about 80,000 cubic feet, a large part of which would enter the main river above Chicot. The Arkansas River was comparatively low.

The decrease at Red River Landing, however, is more marked, as even counting in the discharge of the Atchafalaya the total maximum discharge at that parallel is still about 140,000 cubic feet per second less than the maximum at Chicot. In this case also the discharge of the intervening tributaries must have tended to considerably increase the volume at the lower station. No measurements were made of these tributaries in 1904, but estimating the sum of the discharges at the stages then prevailing on the Yazoo, Red, and Ouachita rivers at 118,000 cubic feet, we have 258,000 cubic feet per second to be accounted for.

The discharge measurements of 1904 at the points mentioned are undoubtedly reliable, and as no new crevasses occurred in the levees during 1904, even taking into account the escape on unleveed fronts and gaps, there is still a large margin of excess at the upper station.

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After making due allowance for the other known causes, as explained hereafter, it seems that this decrease in maximum discharge at the lower station must be mainly due to the tendency to a more uniform velocity, maintained over a longer period, as the flood proceeds down the river, thus passing the same or a larger volume with a smaller maximum discharge at the lower station. The gauge hydrographs of the successive stations also point to this conclusion.

Computing the reservoir capacity of this stretch of the river for the change in stage for the period at 22,000,000,000 cubic feet, the excess discharge of 258,000 second-feet given above would fill this reservoir in twenty-four hours. This excess, however, continued for several days during the limited period of observation, and even allowing another 22,000,000,000 cubic feet for possible seepage and evaporation, the larger part of the excess is still unaccounted for except on the hypothesis just stated.

From the foregoing it seems that a completed levee system would not necessarily produce excessive gauge heights at the lower stations.

The large discharge given in the table for Memphis has not been considered in this connection, since only a single measurement was made in 1904 at that point.

During the low water in December a party in charge of Junior Engineer Geo. H. Wolbrecht, on the small steamer *Mars*, measured the discharge of the Mississippi River at Carrollton, La. The meter work was done from a skiff, one meter on either side, the distance between them being about 5 feet and both being at six-tenths depth. Haskell meter, wheel No. 1, and Price meter No. 25 were used in this work. The resulting velocities by the two meters agreed very closely except on the first day they were used together, when the difference of mean velocities was 0.29 foot per second. After that the difference ranged from 0.004 to 0.11 foot per second. The discrepancy on December 28 was evidently caused by the failure of the register used with the Price meter to work well, and this result was therefore rejected; subsequent to that the results of both meters were given equal weight and the mean tabulated.

The low-water discharge of the Atchafalaya River was measured by the survey party on that river in charge of Assistant Engineer W. G. Comber. The velocities were measured with improvised floats, the double floats being run at surface and mid depth and the rod floats run nearly full depth. The float ranges were 200 feet apart. The soundings were located by stadia readings. The water widths derived from these locations were somewhat discrepant; therefore the water width given by triangulation made in laying out the section was used throughout, making a small correction for change of stage. The resulting discharges are fairly well determined.

During the present high-water period the river stages have not reached, as yet (May 15), the prescribed heights for making discharge measurements.

MISCELLANEOUS.

The annual pamphlet of daily stages of the Mississippi River and its principal tributaries for 1904, containing 134 pages, has been prepared and printed and copies issued.

The daily gage readings at stations on the main river and tributaries were sent out monthly in blueprint. The gauge hydrographs for 1904, in four sheets, have been prepared.

The proceedings of the Commission at the ninety-second, ninety-third, and ninety-fourth sessions, and the monthly reports of operations of the secretary and district officers have been printed.

The third supplement to the general discharge pamphlet has been prepared in part, and the printing begun. This will contain all obtainable discharge results, arranged by stations, on the Mississippi River and its tributaries since 1898, also some earlier results which have become available since the last publication in 1898.

The usual routine work of caring for the scientific records of the secretary's office and cataloguing and indexing same has been attended to.

I beg to acknowledge the valuable assistance of Mr. E. J. Thomas, junior engineer, and of Messrs. E. E. Whitehead and W. M. Garrott, recorders.

Respectfully submitted.

KIVAS TULLY,
Assistant Engineer.

Capt. WM. B. LADUE,
Corps of Engineers, U. S. Army,
Secretary, Mississippi River Commission.

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TABLE No. 4.—*Highest and lowest gauge readings of 1904.*

MISSISSIPPI RIVER.

Station.	Distance from Cairo.	Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean Gulf level.	Highest.					Lowest.				
				Prior to 1904.		1904.		Difference compared with previous highest.	Prior to 1904.		1904.		Difference compared with previous lowest.
				Date.	Gauge reading.	Date.	Gauge reading.		Date.	Gauge reading.	Date.	Gauge reading.	
	Miles above.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Aitkin, Minn. [a]	1,086.0	1,206.78	.....	1899	15.30	Apr. 12	9.80	− 5.50	July 29, 1902	1.30	June 25	3.40	+2.10
St. Paul, Minn	874.0	704.57	.....	Apr. 29, 1881	19.70	Apr. 11, 12	9.90	− 9.80	{Mar. 19, 20, 22, 1896.	− .90	{Aug 19 / Dec. 5, 6	2.60	+3.50
Hastings, Minn	849.0	690.79	.....	Apr. 30, 1881	18.00	Apr. 11–13	11.00	− 7.00	Nov. 23, 1892	− .70	Dec. 5, 6	1.40	+2.10
Winona, Minn	760.0	660.34	.....	June 18, 1880	16.87	Apr. 15, 16	10.00	− 6.87	Dec. 30, 1889	−1.33	Dec. 8–14	2.40	+3.73
Prairie du Chien, Wis	668.0	625.59	.....	June 22, 1880	21.30	June 6	11.10	−10.20	1864	− .20	Aug. 23–28	2.40	+2.60
Rock Island, Ill	510.7	562.37	.....	June 27, 1892	19.40	Mar. 27	10.95	− 8.45	Jan. 5, 6, 1890	− .90	Dec. 18	.70	+1.60
Burlington, Iowa	427.6	531.25	.....	{May 18, 19, 1888 / June 30, 1892}	17.60	Mar. 29	10.80	− 6.80	Dec. 4, 5, 1895	−1.10	Dec. 17	− .05	+1.05
Nashville, Iowa	393.6	516.86	.....	May 17, 18, 1888	12.00	Mar. 30	7.15	− 4.85	Jan. 7, 1890	− .50	Dec. 17, 22, 24	.50	+1.00
Hannibal, Mo	329.4	469.60	.....	June 8, 1903	22.50	Apr. 28, 29	16.40	− 6.10	Jan. 9, 1890	−1.75	Dec. 21	.20	+1.95
Grafton, Ill	233.0	424.09	.....	June 11, 1903	28.70	Apr. 30	24.00	− 4.70	Dec. 9, 1895	− .90	Dec. 22, 23, 31	2.30	+3.20
Alton, Ill	216.2	338.974	.....	June 9, 1903	115.80	Apr. 29	110.90	− 4.90	Nov. 19, 1897	82.70	Dec. 22	84.40	+1.70
St. Louis, Mo	190.8	400.22	.....	June 10, 1903	[b] 38.00	do	33.60	− 4.40	Jan. 2, 1900	−2.52	Dec. 31	.00	+2.52
Chester, Ill	115.5	361.30	.....	June 13, 14, 1903	33.30	Apr. 30, May 1	30.40	− 2.90	Jan. 3, 1900	−4.10	do	1.10	+5.20
Cape Girardeau, Mo	54.5	324.97	.....	June 14, 1903	36.53	May 1	34.10	− 2.43	Feb. 1, 1902	.80	do	5.00	+4.20
Grays Point, Mo. [c]	48.0	321.28	.....	June 14, 15, 1903	35.40	May 2	33.05	− 2.35	Dec. 31, 1880	.95	.....	.....	.....
Cairo, Ill	0	290.84	.....	Feb. 27, 1883	52.17	Apr. 5	49.10	− 3.07	Dec. 24, 1871	−1.00	Dec. 25	3.10	+4.10
	Below.												
Columbus, Ky	21.6	286.76	.....	Feb. 26, 1883	45.58	do	43.91	− 1.67	Nov. 6–8, 1895	.05	do	2.80	+2.75
Morrisson Landing, Mo. [d]	69.0	275.80	.....	Feb. 24, 1884	41.50	.....	.....	.....	Nov. 11–14, 1879	− .17	.....	.....	.....
New Madrid, Mo	70.3	275.72	.....	Mar. 29, 1897	40.27	Apr. 6	38.66	− 1.61	Nov. 6–8, 1895	.55	Dec. 26	2.30	+1.75
Cottonwood Point, Mo	122.5	250.67	.....	Mar. 19, 1903	39.96	Apr. 8	38.15	− 1.81	Nov. 5–8, 1895	−3.35	Dec. 25–28	− .70	+2.65
Fulton, Tenn	175.4	228.55	.....	do	40.15	Apr. 10	37.40	− 2.75	Nov. 7, 8, 1895	.16	Dec. 26	.30	+ .14
Memphis, Tenn	230.0	203.97	.....	Mar. 20, 1903	40.10	Apr. 11	39.20	− .90	Nov. 6–9, 1895	−2.65	do	.65	+3.30
Mhoon Landing, Miss	276.3	181.48	.....	Mar. 25, 1903	41.81	Apr. 12, 13	40.30	− 1.51	Nov. 6–11, 1895	−7.80	Dec. 25	−4.40	+3.40
Helena, Ark	306.5	161.98	.....	Apr. 4, 1897	51.75	Apr. 15	47.62	− 4.13	Nov. 8, 9, 1895	− 3.00	Dec. 26	2.30	+5.30
Sunflower Landing, Miss	352.7	147.08	.....	Mar. 27, 28, 1903	48.00	Apr. 16, 17	44.50	− 3.50	Nov. 12–14, 1895	−1.50	do	3.10	+4.60
Mouth White River, Ark	393.2	128.73	.....	Mar. 28, 29, 1903	53.70	Apr. 18–20	49.50	− 4.20	Dec. 28, 1872	.00	do	4.85	+4.85
Arkansas City, Ark	438.3	116.44	.....	Mar. 27, 28, 1903	52.90	Apr. 19–21	49.00	− 3.90	Nov. 9, 10, 1895	−3.60	do	2.50	+6.10
Greenville, Miss	478.3	108.00	.....	Mar. 27, 1903	49.10	Apr. 21, 22	43.55	− 5.55	Nov. 10, 11, 1895	−2.55	do	1.95	+4.50
Lake Providence, La	542.3	89.62	.....	do	46.48	Apr. 21–24	42.50	− 3.98	Nov. 17, 1895	−5.30	Dec. 16	− .75	+4.55

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Vicksburg, Miss	599.3	66.04	.....	Apr. 16, 1897	52.48	Apr. 25	46.85	− 5.63	Nov. 13, 14, 1895	- 6.50	Dec. 26	.10	+6.60
St. Joseph, La	648.3	52.74	.....	Mar. 28, 1903	48.07	Apr. 25–27	42.75	− 5.32	Nov. 13, 1895	−9.30	Dec. 17	−3.90	+5.40
Natchez, Miss	700.3	36.89	.....	Mar. 28–30, Apr. 2, 1903.	50.35	Apr. 25–29	45.50	− 4.85	Nov. 13–15, 1895	− .85	Dec. 16–19	4.30	+5.15
Red River Landing, La	765.3	.....	3.57	May 14, 15, 1897	50.20	Apr. 28–30	43.70	− 6.50	Nov. 14, 1895	− .60	Dec. 18	3.00	+3.60
Bayou Sara, La	799.8	.....	4.15	May 13–15, 1897	43.70	Apr. 30, May 1	36.70	− 7.00	Nov. 16, 1895	−2.80	Dec. 20	−1.20	+1.60
Baton Rouge, La	853.3	.....	− .42	.....do	40.65	Apr. 29, 30	33.70	− 6.95	Nov. 14, 1894	.45	.....do	1.40	+ .95
Plaquemine, La	854.1	.....	.44	May 13–17, 1897	36.25	.....do	30.00	− 6.25	.....do	− .94	.....do	− .02	+ .92
Donaldsonville, La	885.4	.....	−1.01	May 13, 1897	32.75	Apr. 29	27.15	− 5.60	Nov. 11, 1894	1.00	.....do	1.15	+ .15
College Point, La	904.5	.....	.29	May 15, 1897	27.95	May 1	23.22	− 4.73	Nov. 14, 1894	− .91	Dec. 21	− .50	+ .41
Carrollton, La	957.0	.....	− .13	Apr. 5, 6, 1903	19.42	Apr. 27–29 May 1	16.15	− 3.27	Dec. 27, 1872	−1.60	Dec. 20	− .45	+1.15
Algiers, La	966.0	.....	−2.64	Mar. 25, 26, 29, 1903.	19.90	May 1	17.20	− 2.70	.....	.....	Dec. 20, 28	2.00	.....
Fort Jackson, La	1,039.0	.....	−1.68	Mar. 27, 1903	8.05	Apr. 25, 26	7.20	− .85	Dec. 7, 1893 Nov. 12, 14, 1894.	.30	Dec. 20	.60	+ .30

[a] Gauge discontinued after June 30, 1904.
[b] High water of June 28, 1844, would read 41.4 feet.
[c] Gauge transferred to Cape Girardeau in 1896.
[d] Gauge transferred to New Madrid in 1893.

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TABLE No. 4.—*Highest and lowest gauge readings of 1904*—Continued.

TRIBUTARIES OF MISSISSIPPI RIVER AND THE ATCHAFALAYA.

River.	Station.	Approximate distance of station from—	Elevation of gauge zero above Cairo datum plane.	Elevation of guage zero above mean Gulf level.	Highest.					Lowest.				
					Prior to 1904.		1904.			Prior to 1904.		1904.		
					Date.	Gauge reading.	Date.	Gauge reading.	Difference compared with previous highest.	Date.	Gauge reading.	Date.	Gauge reading.	Difference compared with previous lowest.
		Miles.	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Arkansas	Little Rock, Ark	Mouth.... 176	241.53	.....	May 21, 1892.	31.20	June 11, 12	29.40	− 1.80	Nov. 20, 1887	a 2.00	Jan. 16, 18–20	4.00	+2.00
Do.[b]	Pine Bluff, Ark	Mouth.... 110	200.34	.....	May 22, 1892.	30.50	.....	.....	.....	Nov. 20–23, 1887	− .40	.....	.....	.....
Atchafalaya	Barbre Landing, La	Head 0	.....	3.91	May 13, 14, 1897.	50.95	May 2, 3...	41.25	− 9.70	Oct. 26, 1897	−1.77	Dec. 19, 20	.30	+2.07
Do.[b]	Simmesport, La	Head 4	24.17	.....	May, 1897	49.22	.....	.....	.....	Nov. 8, 1891	−1.60	.....	.....	.....
Do	West Melville, La	Head 31	.....	− .1	Apr. 4, 5, 1903	38.70	May 2–4...	34.3	− 4.4	Nov. 12, 13, 1894	1.0	Dec. 20, 21	3.2	+2.2
Cumberland	Nashville, Tenn	Cairo 244	334.8	.....	Jan. 22, 1882.	55.30	Mar. 27....	37.60	−17.70	Oct. 15, 16, 1878	− .40	Oct. 6	1.00	+1.40
Illinois	Peoria, Ill	Mouth.... 160	454.66	.....	May 9, 1892..	21.9	Mar. 28, 29.	23.00	+ 1.10	Oct. 7, 1890	2.6	Sept. 16, 17	7.1	+4.5
Do.[b]	Beardstown, Ill	Mouth.... 86	444.29	.....	1882.....	21.3	.....	.....	.....	Aug. 11, 12, 1887	.00	.....	.....	.....
Missouri	Kansas City, Mo	Mouth.... 388	737.44	.....	June 1, 2, 1903	c 35.0	July 8.....	25.2	− 9.8	Dec. 2, 1874 d	1.5	Dec. 29–31	2.1	+ .6
Do.[b]	Coles Creek, Mo	Mouth.... 107	433.97	.....	May 15, 1892.	96.76	.....	.....	.....	Dec. 24, 1897	70.7	.....	.....	.....
Do	Hermann, Mo	Mouth.... 103	502.17	.....	June 6, 1903.	c 29.5	Apr. 27....	23.7	− 5.8	Dec. 21, 22, 1878	− .75	Dec. 31	2.0	+2.75
Ohio	Cincinnati, Ohio	Mouth.... 504	447.62	.....	Feb. 14, 1884.	71.06	Mar. 9.....	45.9	−25.16	Sept. 18, 1881	1.92	Oct. 6, 7	3.3	+1.38
Do	Louisville (upper), Ky	Mouth.... 364	419.76	.....	Feb. 16, 1884.	46.60	Mar. 28....	22.9	−23.70	Sept. 10–14, 18–22, 1881; Nov. 14–16, 1895.	1.70	Oct. 7–9	2.0	+ .30
Do	Louisville (lower), Ky	Mouth.... 364	392.85	.....	.....do.....	72.00	.....do....	48.5	−23.50	Oct. 17, 18, 1872	1.60	Oct. 9, 10	2.7	+1.10
Do	Evansville, Ind	Mouth.... 183	349.3	.....	Feb. 19, 1884.	48.8	Apr. 3, 4...	39.8	− 9.00	Nov. 7, 8, 1895	− .3	Oct. 13, 14	.9	+1.20
Do	Paducah, Ky	Mouth.... 45	300.46	.....	Feb. 23, 1881.	54.25	Apr. 4.....	44.7	− 9.55	Oct. 30–Nov. 4, 1895	− .7	Oct. 29–Nov. 3	.2	+ .9
Do	Cairo, Ill	Mouth.... 1	290.84	.....	Feb. 27, 1883.	52.17	Apr. 5.....	49.10	− 3.07	Dec. 24, 1871	−1.00	Dec. 25	3.10	+4.10
Ouachita	Camden, Ark	Mouth Red River... 325	.....	71.10	May 12, 1882.	46.0	June 12...	33.60	−12.40	Aug. 29, 30, 1887	1.80	Sept. 21	1.95	+ .15
Do	Monroe, La	Mouth Red River... 175	.....	30.97	1874.....	49.1	Apr. 15–20.	29.5	−19.6	Sept.–Nov., 1897, 1899, 1901.	.0	Oct. 31, Nov. 1, 5, 6.	.3	+ .3
Red	Fulton, Ark	Mouth.... 508	.....	224.48	July 17, 1876.	35.75	June 14...	31.60	− 4.15	Oct. 20–22, 1896	.10	Dec. 16–23	4.60	+4.50
Do.[b]	Garland, Ark	Mouth.... 450	.....	203.16	Mar. 24, 1894.	28.50	.....	.....	.....	Sept. 22, 25, 1896	− .20	.....	.....	.....
Do	Shreveport, La	Mouth.... 320	.....	140.99	May 28, 1892.	35.70	June 24, 25	28.5	− 7.20	Dec. 2–4, 1894	−5.50	Dec. 22, 23	−1.8	+3.70
Do	Alexandria, La	Mouth.... 110	.....	44.18	June 12, 13, 1892.	38.25	June 30...	29.50	− 8.75	Sept. 29, 1881	−3.7	Dec. 22–25	−1.70	+2.00

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St. Francis...	Bridge St. Louis, Iron Mountain and Southern Rwy.	Mouth....	194	.....	.....	Apr. 4-6, 1897	41.6	Apr. 25, 26.	23.1	−18.5	Nov. 8-11, 1901	− .05	Dec. 1-5, 20-23.....	1.05	+1.10
Do.[b].....	Wittsburg, Ark.....	Mouth....	180	.....	.....	Apr. 28, 1886.	42.02	.....	.....	.....	Oct. 27-31, Nov. 10-14, 1892.	−8.60	.....	.....	.....
Tennessee...	Chattanooga, Tenn...	Cairo	495	651.90	.....	Mar. 11, 1867.	58.6	Mar. 25....	22.1	−36.5	Sept. 11-14, 1881, and 19, 1883.	.00	Oct. 25-27	.09	+ .09
Do.....	Florence, Ala	Cairo	300	418.04	.....	Mar. 19, 1897.	32.20	Mar. 27, 28.	17.20	−15.00	Oct., 1872; Sept. 18, 1878.	− .76	Oct. 28-Nov. 3.....	− .50	+ .26
Do.....	Johnsonville, Tenn...	Cairo	139	348.3	.....	1882.....	48.0	Mar. 30....	28.1	−19.90	Oct. 6-20, 1897	− .3	Oct. 26-Nov. 4.....	− .9	− .6
Wabash	Mount Carmel, Ill.....	Cairo	190	397.86	.....	Aug. 7, 1875..	28.3	Apr. 2.....	27.1	− 1.2	Nov. 7-23, 1895	− .2	Nov. 9-12	.5	+ .7
White	Jacksonport, Ark	Mouth....	360	.....	.....	Mar. 14, 1890.	33.35	Mar. 29....	29.6	− 3.75	Dec. 24, 1872.....	−1.10	Nov. 19-21	− .35	+ .75
Do.....	Clarendon, Ark	Mouth....	134	158.9	.....	Mar. 20, 1890.	36.63	Apr. 8.....	29.60	− 7.03	Nov. 22, 1887	4.07	Nov. 24-26	5.25	+1.18
Yazoo	Yazoo City, Miss	Mouth....	65	93.34	.....	1882.....	36.50	Apr. 26-29.	22.6	−13.90	1875.....	−4.30	Nov. 16-21, 26-30 ..	−3.0	+1.30

[a] Low water of 1879, adopted by the U. S. Engineer Office at Little Rock, Ark., reads 2.01 feet on present gauge.
[b] Discontinued.
[c] High water of June, 1844 = 37 feet.
[d] January 6 gauge read −0.1; probably affected by ice.
[e] High water of June, 1844, would read 35.6 feet.

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TABLE No. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges.*

NOTES.—This table is in continuation of Table No. 9, published in Report of Chief of Engineers, 1898, pages 3250 et seq. The present table contains also some additional stations. The United States Engineer gauges marked with an asterisk are in charge of the secretary, Mississippi River Commission. Extreme readings for each station are in italics.

MISSISSIPPI RIVER—AITKIN, MINN. (1,086 MILES ABOVE CAIRO).

[M. R. C. gauge; zero 1,206.78 feet above the Cairo datum plane. This gauge was established by the Mississippi River Commission for use in connection with the survey of the river in that vicinity, and was discontinued after June 30, 1904.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1899..		*a 15.3*		
1902..	May 27, 28	18.05	July 29	*1.3*
1903..	October 14, 15	18.05	June 25	1.6
1904..	April 12	9.8	.....do	3.4

MISSISSIPPI RIVER—ST. PAUL, MINN. (874 MILES ABOVE CAIRO).

[Weather Bureau gauge; zero 704.6 feet above the Cairo datum plane.]

1866..			September 22, October 21	2.2
1867..	July 23	b 18.6	November 29	3.0
1868..	April 4	b 9.3	December 9	2.0
1869..	September 24–27	16.1	July 31, August 1	2.8
1872..	May 19–22	b 7.7	October 26, 27	1.9
1873..	April 21	16.4	September 24	2.1
1874..	July 2	11.6	November 25–28	b 3.0
1875..	April 16	b 18.0	August 22	b 2.1
1876..	April 10	11.0	November 26	1.9
1877..	May 25, 26	7.7	August 24–29, September 8–13	1.8
1878..	April 27	6.7	December 3, 4	.6
1879..	July 11	10.8	September 28	.9
1880..	June 17, 18	15.2	October 10–14	1.7
1881..	April 29	*19.7*	August 14, 15	3.3
1882..	April 13	13.3	November 29, 30	2.6
1883..	April 22	12.5	September 16, 30	1.5
1884..	May 5–7	10.2	August 10	1.8
1885..	June 18, 19	7.4	November 22, 27	1.9
1886..	March 29, 31, April 1	8.2	August 15	1.2
1887..	April 17	9.6	November 22, 23	.8
1888..	April 14	14.4	December 10, 11	2.0
1889..	May 21	4.5	November 24	1.1
1890..	June 23	7.0	December 1	.6
1891..	April 17	6.4	November 18	.1
1892..	May 26	12.6	November 24	1.0
1893..	May 5–7	14.7	November 26	.6
1894..	May 21	11.8	July 30, August 6	.2
1895..	June 16, 17	4.6	March 22	.2
1896..	April 18	10.7	March 19, 20, 22	— .9
1897..	April 6	18.0	November 27	2.3
1898..	June 8, 9	10.7	August 15, 20, September 8–10	2.7
1899..	June 22, 23	11.0	December 7, 8	2.5
1900..	October 7	6.6	July 2	.7
1901..	April 12	7.5	December 7, 8	c. 7
1902..	May 26, 27	7.5	March 10	1.1
1903..	October 14	13.5	November 22, 23	3.0
1904..	April 11, 12	9.9	August 19, December 5, 6	2.6
1905..	May 18, 19	11.7		

a High water; day not given.
b Gauge record is incomplete, and possibly the extreme high or low reading is not included.
c River frozen.

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TABLE NO. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

MISSISSIPPI RIVER—HASTINGS, MINN. (849 MILES ABOVE CAIRO).

[U. S. engineer gauge; zero 690.79 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1881..	April 30	*18.0*		
1892..			November 23	—0.7
1898..	June 8	13.4	November 27	.5
1899..	June 18–20	11.3	February 6–18	1.4
			December 17, 18	1.8
1900..	October 9–11	7.7	July 2, August 6	.3
1901..	April 11–13	8.8	December 9	.4
1902..	June 10	8.1	April 23–25	.8
1903..	October 12–14	13.8	February 16–23	1.5
1904..	April 11–13	11.0	December 5, 6	1.4
1905..	May 19–21	12.0		

MISSISSIPPI RIVER—WINONA, MINN. (760 MILES ABOVE CAIRO).

[U. S. engineer gauge; zero, 660.34 feet above the Cairo datum plane.]

1880..	June 18	*16.87*		
1889..			December 30	—1.33
1898..	June 13, 14	10.7	September 27–30	1.5
1899..	June 18, 19	11.7	February 4–6	1.9
			August 16–18	2.5
1900..	October 10	11.8	July 2	1.7
1901..	April 12–15	9.5	December 14	.8
1902..	November 21, 22	7.2	August 29	1.7
1903..	September 19, 20	14.6	February 19	2.8
1904..	April 15, 16	10.0	December 8–14	2.4
1905..	June 11	13.8		

MISSISSIPPI RIVER—PRAIRIE DU CHIEN, WIS. (668 MILES ABOVE CAIRO).

[U. S. Weather Bureau gauge; zero, 625.59 feet above the Cairo datum plane.]

1864..				—0.8
1880..	June 10	*21.5*		
1898..	June 19, 20	[a]9.73	November 26	[a]— .17
1899..	June 19–21	14.2	February 1, 13, 14	1.0
			October 18–20	2.0
1900..	October 15	14.4	July 2, 3	1.2
1901..	April 18–20	11.0	September 7	1.4
1902..	May 24	10.8	August 31, September 1	.9
1903..	September 25	16.5	November 26	3.7
1904..	June 6	11.1	August 28–28	2.4
1905..	June 16	16.4		

MISSISSIPPI RIVER—ROCK ISLAND, ILL. (511 MILES ABOVE CAIRO).

[U. S. engineer gauge; zero, 562.37 feet above the Cairo datum plane.]

1864..				0.0
1872..	May 28	9.3	November 24	.7
1873..	May 6	12.2	November 24, December 2	.8
1874..	March 10	14.9	December 2	.5
1875..	April 30	13.0	November 27	.1
1876..	April 17	13.4	February 24	1.5
			December 2	1.9
1877..	April 5	9.9	September 15, 25–30	.8
1878..	July 17	7.1	December 14, 15	.0
1879..	June 1, 2	7.8	October 1	1.1
1880..	June 26	13.4	February 2, 3	1.3
			November 20	1.5

[a] 0.27 foot subtracted from readings on North McGregor gauge, whose zero was 625.32 feet above the Cairo datum plane.

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TABLE NO. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

MISSISSIPPI RIVER—ROCK ISLAND, ILL. (511 MILES ABOVE CAIRO)—Continued.

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1881..	October 25	17.8	August 26	2.6
1882..	April 23	14.1	January 8, 9	1.7
			October 4–6	2.5
1883..	May 2	13.3	November 19	1.8
1884..	March 28, 29	11.9	December 3	1.8
1885..	May 9	10.2	December 6	2.5
1886..	May 3	12.6	November 28	.4
1887..	February 12	12.80	August 9, 10	1.0
1888..	May 15–17	18.60	December 21, 22, 24	.4
1889..	March 12	7.80	December 1–3 [a]	-- .2
1890..	July 1	11.90	January 5, 6	- .9
			December 10–12	.1
1891..	May 3–5	10.30	November 20	— .4
1892..	June 27	*19.40*	November 30	.0
1893..	March 18	14.50	November 28–30	.0
1894..	May 31	12.30	December 6, 7	— .2
1895..	March 4	8.90	November 30	— .2
1896..	May 28, 29	12.10	December 6	.5
1897..	April 17, 18	15.10	December 2	— .3
1898..	February 14	9.90	November 30	— .4
1899..	June 25	11.90	December 22	.5
1900..	March 18	13.10	December 16, 18	.9
1901..	March 16	9.60	December 10	1.4
1902..	May 26, 27	10.40	December 12	1.6
1903..	October 1	13.65	December 2	2.0
1904..	March 27	10.95	December 18	.7
1905..	June 21	14.30		

MISSISSIPPI RIVER—BURLINGTON, IOWA (428 MILES ABOVE CAIRO).

[U. S. engineer gauge; zero 531.25 feet above the Cairo datum plane.]

1864..				0.0
1878..			December 12, 19	.8
1879..	July 15	7.1	December 18 [b]	.6
1880..	June 28	15.8	November 22 [c]	.6
1881..	September 30	16.5	August 28–30 [d]	2.5
1882..	April 25	13.3	September 28–October 6 [e]	3.0
1883..	May 5	11.8	December 19	1.4
1884..	March 30, 31	13.8	December 5	2.7
1885..	May 9, 10	9.8	December 13	2.5
1886..	May 7	12.0	December 3 [f]	.0
1887..	May 2–4	9.4	December 1, 2	— .2
1888..	May 18, 19	*17.6*	December 23	.6
1889..	May 24, 25	6.0	December 4	.4
1890..	June 30, July 1	11.6	January 9	-- .6
			December 13	.5
1891..	May 4–6	9.7	November 30	— .8
1892..	June 30	*17.6*	December 18, 19	.3
1893..	May 16	12.5	December 4	— .8
1894..	June 3, 4	10.5	December 31	— .4
1895..	March 2–4	5.3	December 4, 5	—*1.1*
1896..	June 3	10.3	January 3	— .6
			October 25, 26	.1
1897..	April 28, 29	13.3	December 5	— .7
1898..	March 14, 15, 17	6.8	December 7	— .5
1899..	June 28	10.4	December 27	— .9
1900..	October 23, 24	9.0	January 29	.4
			December 21	.5
1901..	March 24	9.4	December 12	.3
1902..	July 21	10.8	January 27	.6
1903..	June 5, 6	14.9	December 6	1.8
1904..	March 29	10.8	December 17	— .05
1905..	June 25	12.2		

[a] No record January and February.
[b] Closed by ice from December 19.
[c] Closed by ice January, February, and December.
[d] Closed by ice to March.
[e] Closed by ice February, November, and December.
[f] Closed by ice to January 25.

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TABLE No. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

MISSISSIPPI RIVER—NASHVILLE, IOWA (394 MILES ABOVE CAIRO).

[U. S. engineer gauge; zero 516.86 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1864..	.....	.....	.....	.0
1878..	.....	.....	September 18, 19, December 12[a]	1.1
1879..	June 2	4.9	September 18, 19[b]	.9
1880..	June 29	10.6	November 22	.9
1881..	October 30–November 1	11.3	August 15–17, 27–31	1.9
1882..	April 25	9.2	December 12	.8
1883..	February 23, 25	9.3	December 20	.5
1884..	April 1	9.5	December 4–6	1.5
1885..	January 21, 23	7.5	December 8	.9
1886..	May 6	8.6	December 4	.5
1887..	May 3, 4	6.6	December 1	.2
1888..	May 17, 18	*12.0*	December 23	.3
1889..	April 20, June 8, 18	3.8	December 4, 5	.3
1890..	July 1	7.4	January 7 December 9–11	.5 .6
1891..	March 27, 28, April 9, 24, May 1–8	6.0	December 2, 3, 8, 9	.1
1892..	June 29	11.8	November 27–29	.4
1893..	May 14–17	8.3	November 25–December 1	.2
1894..	June 4, 5	6.6	December 31	.2
1895..	March 4	2.9	January 2, December 2, 7, 8	.1
1896..	June 3, 4	6.8	January 2, 22–25 December 7, 8	.2 .4
1897..	April 28, 29	9.2	December 8, 9	.4
1898..	March 20	4.8	December 4–6	.2
1899..	June 29	6.7	December 28	.3
1900..	March 1, October 24	5.9	January 29 December 21, 31	.6 .7
1901..	March 24–26	6.4	December 14	.55
1902..	July 21–22	7.5	January 22	.6
1903..	June 6	10.55	December 14	.8
1904..	March 30	7.15	December 17, 22, 24	.5
1905..	June 10	9.1	.....	.....

MISSISSIPPI RIVER.—HANNIBAL, MO. (329 MILES ABOVE CAIRO).

[Bridge gauge; zero 469.6 feet above the Cairo datum plane.]

1890..	.....	.....	January 9	*−1.75*
1898..	May 21	11.7	December 6	−0.7
1899..	May 23	15.0	December 30	−1.5
1900..	March 15	13.0	January 31	−0.3
1901..	April 8	12.9	February 7	−0.6
1902..	July 23	16.6	June 11, 12	1.2
1903..	June 8	*22.5*	December 14, 15	0.5
1904..	April 28, 29	16.4	December 21	[c]0.2
1905..	June 13	18.3		

MISSISSIPPI RIVER.—GRAFTON, ILL. (238 MILES ABOVE CAIRO).

[U. S. Weather Bureau gauge; zero 424.09 feet above the Cairo datum plane.]

1895..	.....	.....	December 9	*−0.9*
1898..	May 23	18.1	December 9, 10	1.9
1899..	May 25	18.3	December 31	0.8
1900..	March 16	17.3	February 8	1.0
1901..	April 10, 11	16.6	December 17, 18	1.4
1902..	July 26	20.4	January 29	0.8
1903..	June 11	*23.7*	December 16	2.5
1904..	April 30	24.0	December 22, 23, 31	2.3
1905..	June 16	18.3		

[a] No record from December 13.
[b] No record January and February.
[c] The ice was cut away from gauge on the 21st at 11.30 a. m.

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TABLE No. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

MISSISSIPPI RIVER.—ALTON, ILL. (216 MILES ABOVE CAIRO).

[Bridge gauge; zero 833.97 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1896..	May 26	105.4	February 22	86.0
1897..	May 2	108.45	December 19	82.7
1898..	March 24	102.0	December 11	84.2
1899..	May 25, 27	102.9	December 30	84.0
1900..	March 16	101.7	January 1	84.7
			December 31	85.25
1901..	April 11	100.7	December 17, 18	83.7
1902..	July 25	105.0	January 28, 29	82.7
1903..	June 9	*115.8*	December 15, 16	84.9
1904..	April 29	110.9	December 22	84.4
1905..	July 6	102.4		

MISSISSIPPI RIVER.—ST. LOUIS, MO. (191 MILES ABOVE CAIRO).

[U. S. engineer gauge*; zero 400.22 feet above the Cairo datum plane.]

1898..	May 23	27.20	December 11	0.3
1899..	April 27	25.68	December 31	−0.79
1900..	March 16	23.53	January 2	−*2.52*
			December 31	3.10
1901..	April 18	22.58	December 19	−1.94
1902..	July 26	26.89	January 30	−1.10
1903..	June 10	[a]*33.00*	December 18	0.55
1904..	April 29	33.60	December 31	0.00
1905..	July 15	25.80		

MISSISSIPPI RIVER.—CHESTER, ILL. (116 MILES ABOVE CAIRO).

[U. S. Weather Bureau gauge; zero 361.3 feet above the Cairo datum plane.]

1898..	May 24	22.2	January 5	0.1
1899..	April 27	21.4	December 30	0.1
1900..	March 16	19.4	January 3	−*.1*
1901..	April 19	19.7	December 21	−0.3
1902..	July 27	22.8	January 30, 31	−1.4
1903..	June 13, 14	*33.3*	December 18	1.4
1904..	April 30, May 1	30.4	December 31	1.1
1905..	July 16	22.8		

MISSISSIPPI RIVER.—CAPE GIRARDEAU, MO. (54 MILES ABOVE CAIRO).

[M. R. C. gauge; zero 324.97 feet above the Cairo datum plane.]

1898..	March 28	27.8	December 15, 16	2.8
1899..	April 27, 28	26.0	February 23	3.6
			December 30	4.0
1900..	March 17	25.0	February 4	2.4
1901..	April 19	24.6	December 20	2.0
1902..	July 26–28	26.3	February 1	*0.8*
1903..	June 14	*36.53*	December 19	4.7
1904..	May 1	34.1	December 31	5.0
1905..	July 16	26.9		

[a] High water of June 28, 1844, as reported would read 41.4.

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TABLE NO. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

OHIO RIVER—CAIRO, ILL.

[U. S. engineer gauge*: zero 290.84 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge. reading.
		Feet.		*Feet.*
1871..			December 24	*—1.0*
1883..	February 27	*52.17*		
1898..	April 6	49.8	October 10	7.67
1899..	April 2	46.24	October 16	2.98
1900..	March 17	39.17	September 21	5.78
1901..	May 1, 2	43.2	November 28	2.88
1902..	March 17	42.14	September 26	7.25
1903..	March 16, 17	50.57	December 20	2.85
1904..	April 5	49.10	December 25	3.10
1905..	May 24	38.56		

MISSISSIPPI RIVER—COLUMBUS, KY.[a] (22 MILES BELOW CAIRO).

[M. R. C. gauge; zero 286.76 feet above the Cairo datum plane.]

1883..	February 26	*45.58*		
1895..			November 6–8	*0.05*
1898..	April 6	43.98	October 10	7.68
1899..	April 4	42.00	October 27	2.97
1900..	March 17	36.93	September 21	6.10
1901..	May 1	39.83	November 29	3.59
1902..	March 17	38.60	September 26	7.50
1903..	March 17	44.50	December 21	2.99
1904..	April 5	43.91	December 25	2.8
1905..	May 24	35.80		

MISSISSIPPI RIVER—NEW MADRID, MO. (70 MILES BELOW CAIRO).

[M. R. C. gauge; zero 275.72 feet above the Cairo datum plane.]

1895..			November 6–8	*0.55*
1897..	March 29	*40.27*		
1898..	April 7, 8	38.31	October 10	6.43
1899..	March 30	36.10	October 28	2.60
1900..	March 17	31.98	September 22	5.28
1901..	May 3	34.21	November 29	3.26
1902..	March 18	33.24	September 27	6.85
1903..	March 17	39.56	December 21	2.80
1904..	April 6	38.66	December 26	2.30
1905..	March 18, May 24	30.75		

MISSISSIPPI RIVER—COTTONWOOD POINT, MO. (122 MILES BELOW CAIRO).

[M. R. C. gauge; zero 250.67 feet above the Cairo datum plane.]

1895..			November 5–8	*—3.55*
1898..	April 8–10	38.53	October 11	4.6
1899..	March 30, April 3, 4, 7, 8	36.45	October 30–November 1	—.2
1900..	March 18	31.40	September 23	2.45
1901..	May 4	33.85	November 29–December 1	—.8
1902..	March 19	32.80	September 27	3.5
1903..	March 19	*59.96*	December 21	.4
1904..	April 8	38.15	December 25–28	.7
1905..	March 18, 19	30.84		

[a] Gauge moved from Belmont, Mo., in October, 1902. No change in elevation.

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TABLE No. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

MISSISSIPPI RIVER—FULTON, TENN. (175 MILES BELOW CAIRO).

[M. R. C. gauge; zero 228.55 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1895..	.....	.....	November 7, 8	*0.16*
1898..	April 10	38.30	October 11	6.55
1899..	April 7	34.90	October 30	2.63
1900..	March 19	28.15	September 24	4.30
1901..	May 6	30.60	November 30–December 1	1.55
1902..	March 20	29.55	September 23	4.30
1903..	March 19	*40.15*	December 22	1.30
1904..	April 10	37.40	December 26	.30
1905..	March 20	27.41	.....	.....

MISSISSIPPI RIVER—MEMPHIS, TENN. (230 MILES BELOW CAIRO).

[U. S. engineer gauge*; zero 208.97 feet above the Cairo datum plane.]

1895..	.....	.....	November 6–9	*−2.65*
1898..	April 10	37.22	October 12	4.50
1899..	April 1–11	35.20	October 31–November 1	.54
1900..	March 19	29.47	September 24	2.11
1901..	May 6	32.12	December 1, 2	−.30
1902..	March 21	30.90	September 29	2.90
1903..	March 20	*40.10*	December 23	.95
1904..	April 11	39.20	December 26	.65
1905..	March 21	28.94	.....	.....

MISSISSIPPI RIVER—MHOON LANDING, MISS. (276 MILES BELOW CAIRO).

[M. R. C. gauge; zero 181.48 feet above the Cairo datum plane.]

1895..	.....	.....	November 6–11	*−7.80*
1898..	April 14–16	39.10	October 12–13	.80
1899..	April 7–14	38.60	October 30–November 2	−4.8
1900..	March 19–21	32.50	September 25, 26	−3.83
1901..	May 8	35.40	November 30	[a] −3.72
1902..	March 22	34.30	September 29	1.9
1903..	March 25	*41.81*	December 23	?−3.7
1904..	April 12, 13	40.30	December 25	−4.4
1905..	May 27–29	32.20	.....	.....

MISSISSIPPI RIVER—HELENA, ARK. (306 MILES BELOW CAIRO).

[U. S. engineer gauge*; zero 161.98 feet above the Cairo datum plane.]

1895..	.....	.....	November 8, 9	*−5.00*
1897..	April 4	*51.75*	.....	.....
1898..	April 17	49.10	October 13	7.80
1899..	April 12–15	46.75	November 1, 2	1.70
1900..	March 21	38.25	September 26	4.76
1901..	May 8, 9	41.45	December 2	1.45
1902..	March 23, 24	39.58	September 29	6.38
1903..	March 26, 27	51.00	December 23	2.80
1904..	April 15	47.62	December 26	2.30
1905..	May 29	37.77	.....	.....

[a] No record for December 1–6.

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TABLE No. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

MISSISSIPPI RIVER—SUNFLOWER LANDING, MISSISSIPPI (353 MILES BELOW CAIRO).

[M. R. C. gauge; zero 147.06 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1895..	.....	.....	November 12–14	*—1.50*
1898..	April 17–19	46.00	October 13, 14	8.50
1899..	April 12–16	44.80	November 1–3	2.76
1900..	March 22, 23	37.10	September 25, 26	6.30
1901..	May 8–10	40.50	December 3, 4	2.85
1902..	March 24	38.75	September 30	7.20
1903..	March 27, 28	*48.00*	December 24	2.90
1904..	April 16, 17	44.50	December 26	3.10
1905..	May 30	37.60	.....	.....

MISSISSIPPI RIVER—MOUTH OF WHITE RIVER, ARKANSAS (393 MILES BELOW CAIRO).

[U. S. engineer gauge;* zero 128.73 feet above the Cairo datum plane.]

1872..	.....	.....	December 28	*0.00*
1898..	April 19	51.05	January 12	12.70
			September 12	12.80
1899..	April 15, 16	48.49	November 3	4.70
1900..	March 24	40.55	September 25, 26	8.63
1901..	May 12	44.70	December 2–4	4.55
1902..	March 28	43.30	September 30	9.75
1903..	March 27–29	*53.70*	December 24	?5.10
1904..	April 18–20	49.50	December 26	4.85
1905..	June 1, 2	44.15	.....	.....

MISSISSIPPI RIVER—ARKANSAS CITY, ARK. (433 MILES BELOW CAIRO).

[M. R. C. gauge; zero 116.44 feet above the Cairo datum plane.]

1895..	.....	.....	November 9, 10	*—3.60*
1898..	April 19–21	51.2	January 13	9.20
			September 12	?9.90
1899..	April 15–20	48.6	November 2–5	1.00
1900..	March 25	39.3	September 25, 26	4.95
1901..	May 12, 13	43.3	November 29–December 4	1.00
1902..	March 29	41.4	October 1	6.80
1903..	March 27, 28	*52.9*	December 24	2.10
1904..	April 19–21	49.0	December 26	2.50
1905..	June 2, 3	43.2	.....	.....

MISSISSIPPI RIVER—GREENVILLE, MISS. (478 MILES BELOW CAIRO).

[M. R. C. gauge; zero 108 feet above the Cairo datum plane.]

1895..	.....	.....	November 10, 11	*—2.55*
1898..	April 21	46.20	January 13	7.20
			September 13	7.95
1899..	April 17–20	43.00	November 3–5	1.20
1900..	March 25	33.75	September 27	4.45
1901..	May 13	37.40	December 4	.85
1902..	March 29	36.05	October 1	6.00
1903..	March 27	*49.10*	December 25	2.70
1904..	April 21, 22	43.55	December 26	1.95
1905..	June 3, 4	36.80	.....	.....

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TABLE No. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

MISSISSIPPI RIVER—LAKE PROVIDENCE, LA. (542 MILES BELOW CAIRO).

[U. S. engineer gauge *; zero 89.62 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1895..			November 17	*—5.30*
1898..	April 23	44.35	September 14, 15	6.75
1899..	April 16–21	41.65	November 5	—2.15
1900..	March 25	32.95	September 27, 28	2.37
1901..	May 14	36.45	December 5, 6	—.85
1902..	March 30, April 16, 17	34.95	October 2	5.30
1903..	March 27	*46.48*	December 26, 27	.70
1904..	April 21–24	42.50	December 16	—.75
1905..	June 4	36.50		

MISSISSIPPI RIVER—VICKSBURG (KLEINSTON), MISS. (599 MILES BELOW CAIRO).

[U. S. engineer gauge*; zero 66.04 feet above the Cairo datum plane.]

1895..			November 13, 14	*—6.50*
1897..	April 16	*52.48*		
1898..	April 23–25	49.40	January 1	8.00
			September 14	8.57
1899..	April 17–23	47.80	November 6	—1.58
1900..	March 27	38.00	September 28	2.52
1901..	May 16	41.50	December 5	—2.32
1902..	April 17	41.22	October 2	4.73
1903..	March 28	51.80	December 27	.27
1904..	April 25	46.85	December 26	.10
1905..	June 5, 6	40.75		

MISSISSIPPI RIVER—ST. JOSEPH, LA. (648 MILES BELOW CAIRO).

[M. R. C. gauge; zero 52.74 feet above the Cairo datum plane.]

1895..			November 13	*—9.30*
1898..	April 25, 26	45.10	September 15	5.75
1899..	April 21–24	43.25	November 5, 6	—5.20
1900..	March 27	33.70	September 29	—.05
1901..	May 15, 16	36.90	December 1	5.87
1902..	April 18	37.15	October 3	1.00
1903..	March 28	*48.07*	December 27–28	4.25
1904..	April 25–27	42.75	December 17	—3.90
1905..	June 7	37.40		

MISSISSIPPI RIVER—NATCHEZ, MISS. (700 MILES BELOW CAIRO).

[U. S. engineer gauge *; zero 36.89 feet above the Cairo datum plane.]

1895..			November 13–15	*— 0.55*
1898..	April 26, 27	47.40	September 15, 16	12.48
1899..	April 23–25	46.15	November 7, 8	2.60
1900..	March 28	37.00	September 29	6.50
1901..	May 16, 17	39.80	December 6	2.05
1902..	April 18	40.25	October 3	7.50
1903..	March 28–30, April 2	*50.35*	December 28	4.20
1904..	April 25–29	45.50	December 16, 19	4.30
1905..	June 7, 8	41.30		

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TABLE NO. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

MISSISSIPPI RIVER—RED RIVER LANDING, LA. (765 MILES BELOW CAIRO).

[U. S. engineer gauge*; zero 3.57 feet above the mean Gulf level.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1895..	.....	.....	November 14	*—0.60*
1897..	May 14, 15	*50.20*	.....	.....
1898..	April 28–30	44.30	September 16	9.46
1899..	April 22–27	43.30	November 3, 4	1.00
1900..	March 29	36.30	September 29–October 1	5.35
1901..	May 15–18	37.30	November 18, 30	2.00
1902..	April 18–20	38.80	October 1	7.80
1903..	April 8, 9	50.08	December 28, 29	2.80
1904..	April 28–30	43.70	December 18	8.00
1905..	June 9	40.77	.....	.....

MISSISSIPPI RIVER—BAYOU SARA, LA. (800 MILES BELOW CAIRO).

[M. R. C. gauge; zero 4.15 feet above the mean Gulf level.]

1895..	.....	.....	November 16	*—2.80*
1897..	May 13–15	*43.70*	.....	.....
1898..	April 27–May 1	37.50	September 16, 17	4.00
1899..	April 21–26	36.70	November 3	—1.40
1900..	March 28–30	29.10	October 1	?1.44
1901..	May 16–18	30.40	November 24, 25	—1.40
1902..	April 18–20	31.70	October 1	2.60
1903..	April 8–10	43.34	December 28, 29	— .80
1904..	April 30, May 1	36.70	December 20	—1.20
1905..	June 9, 10	33.40	.....	.....

MISSISSIPPI RIVER—BATON ROUGE, LA. (833 MILES BELOW CAIRO).

[U. S. engineer gauge*; zero 0.42 foot below the mean Gulf level.]

1894..	.....	.....	November 14	*0.45*
1897..	May 13–15	*40.65*	.....	.....
1898..	April 29–May 1	34.60	September 17	5.41
1899..	April 21–28	33.70	November 3, 5	1.20
1900..	March 28–30	27.25	September 29	3.20
1901..	May 15–19	28.21	November 25	1.30
1902..	April 18, 19	29.40	October 1	4.10
1903..	April 7, 8, 10	40.05	December 29–30	1.80
1904..	April 29, 30	33.70	December 20	1.40
1905..	June 9, 11	30.80	.....	.....

MISSISSIPPI RIVER—PLAQUEMINE, LA. (854 MILES BELOW CAIRO).

[M. R. C. gauge; zero 0.44 foot above the mean Gulf level.]

1894..	.....	.....	November 14	*—0.94*
1897..	May 13–17	*36.25*	.....	.....
1898..	April 29–May 1	30.60	October 18	3.40
1899..	April 21, 25	30.10	November 4	0.04
1900..	March 29	23.85	September 29, 30	1.88
1901..	May 15, 17	24.45	November 25	.00
1902..	April 19, 20	25.60	October 1, 2	2.50
1903..	April 5, 7, 8	36.12	December 30	.45
1904..	April 29, 30	30.00	December 20	— .02
1905..	June 10, 11	27.05	.....	.....

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TABLE No. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

MISSISSIPPI RIVER—DONALDSONVILLE, LA. (885 MILES BELOW CAIRO).

[U. S. engineer gauge *; zero 1.01 feet below the mean Gulf level.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1894..	.....	.....	November 11	*1.00*
1897..	May 13	*32.76*	.....	.....
1898..	April 30	28.00	January 1	4.30
			September 17, 18	4.42
1899..	April 21	27.50	October 18	2.15
1900..	March 29, 30	21.80	September 24–26	3.13
1901..	May 19	22.30	November 25	1.12
1902..	April 19	28.30	November 23	3.05
1903..	April 7	32.23	December 31	1.45
1904..	April 29	27.15	December 20	1.15
1905..	June 10, 11	24.30	.....	.....

MISSISSIPPI RIVER—COLLEGE POINT, LA. (904 MILES BELOW CAIRO).

[M. R. C. gauge; zero 0.29 foot above the mean Gulf level.]

1894..	.....	.....	November 14	*—0.91*
1897..	May 15	*27.95*	.....	.....
1898..	April 27, 30	23.59	January 1	2.00
			September 17	2.28
1899..	April 21	23.15	November 5	— .39
1900..	March 28, 29	18.25	September 29	.87
1901..	May 15	18.60	November 25	— .47
1902..	April 19	19.50	October 4, November 18	1.25
1903..	April 5, 6	27.81	December 28	— .50
1904..	May 1	23.22	December 21	— .50
1905..	June 10	20.60	.....	.....

MISSISSIPPI RIVER—CARROLLTON, LA. (957 MILES BELOW CAIRO).

[U. S. engineer gauge *; zero 0.13 foot below the mean Gulf level.]

1872..	.....	.....	December 27	*—1.60*
1898..	April 25	15.90	January 1, 2	1.00
			October 29, December 25	1.80
1899..	April 21	16.00	November 4	.00
1900..	March 27	12.60	January 21	?.80
1901..	May 17, 20	12.66	December 18, 21	.01
1902..	April 14, 18, 21	13.35	November 17	1.10
1903..	March 29, April 5, 6	*19.42*	December 28–31	— .10
1904..	April 27–29, May 1	16.15	December 20	— .45
1905..	June 10	14.02	.....	.....

MISSISSIPPI RIVER—ALGIERS, LA. (966 MILES BELOW CAIRO).

[U. S. naval station gauge; zero 2.64 feet below the mean Gulf level.]

1903..	March 25, 26, 29	19.90	December 30	2.20
1904..	May 1	17.2	December 20, 28	2.00
1905..	June 8, 11	15.3	.....	.....

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TABLE NO. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

MISSISSIPPI RIVER—FORT JACKSON, LA. (1,039 MILES BELOW CAIRO).

[M. R. C. gauge; zero 1.68 feet below the mean Gulf level.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1893..	.....	.....	December 7.....	*0.5*
1894..	.....	.....	November 12, 14.....	*.5*
1898..	April 23, 26.....	6.70	{January 2.....	.90
			{December 26.....	1.30
1899..	April 21.....	6.98	December 4.....	.88
1900..	April 20, 28.....	5.90	January 14.....	1.25
1901..	May 8, 9, 18.....	[a]6.00	November 25.....	.70
1902..	April 14.....	6.85	February 3.....	1.40
1903..	March 27.....	*8.05*	December 31.....	.65
1904..	April 25, 26.....	7.20	December 20.....	.60
1905..	June 4, 5, 8–10.....	6.5	.....	.....

ARKANSAS RIVER—LITTLE ROCK, ARK. (176 MILES FROM MOUTH).

[U. S. engineer gauge *; zero 241.53 feet above the Cairo datum plane.]

1887..	.....	.....	November 20.....	[b]*2.00*
1892..	May 21.....	*51.20*	.....	.....
1898..	May 11.....	29.30	{January 5.....	4.00
			{November 18–21.....	4.80
1899..	.....do.....	25.90	October 26–November 2.....	3.50
1900..	October 6.....	14.90	September 21.....	3.20
1901..	April 20.....	19.10	October 7, 8.....	2.50
1902..	December 19.....	20.60	January 16, 17.....	2.70
1903..	June 2.....	26.20	December 11, 12, 15, 24.....	4.10
1904..	June 11, 12.....	29.40	January 16, 18–20.....	4.00
1905..	June 1.....	24.20	.....	.....

ATCHAFALAYA RIVER—BARBRE LANDING, LA. (0 MILES FROM HEAD).

[M. R. C. gauge; zero 3.91 feet above the mean Gulf level.]

1897..	May 13, 14.....	*50.95*	October 26.....	*−1.77*
1898..	April 30–May 3.....	42.80	September 17.....	7.10
1899..	April 25–28.....	41.60	November 5.....	[c]−1.30
1900..	March 30.....	33.80	September 28.....	3.00
1901..	May 15–18.....	34.55	November 21, 22.....	.16
1902..	April 21.....	37.38	September 30.....	7.10
1903..	April 7–11.....	50.60	December 28–30.....	1.30
1904..	May 2, 3.....	41.25	December 19, 20.....	.30
1905..	June 9–11.....	40.20	.....	.....

ATCHAFALAYA RIVER—WEST MELVILLE, LA. (81 MILES FROM HEAD).

[U. S. Weather Bureau gauge; zero 0.1 foot below the mean Gulf level.]

1894..	.....	.....	November 12, 13.....	*1.0*
1898..	April 29–May 4.....	33.9	September 18.....	9.5
1899..	April 21–May 1.....	33.4	November 6, 7.....	1.6
1900..	March 28–May 31.....	30.5	September 29.....	5.7
1901..	May 16–19.....	31.4	November 22.....	2.8
1902..	April 19–22.....	32.9	October 1.....	9.2
1903..	April 4, 5.....	*33.7*	December 29.....	3.9
1904..	May 2–4.....	34.3	December 20, 21.....	3.2
1905..	June 7–13.....	34.1	.....	.....

[a] August 14, 1901, 7.2 feet caused by storm.

[b] Low water of 1879, adopted by the U. S. engineer office at Little Rock, Ark., reads 2.01 feet on present gauge.

[c] At inspection on November 11 gauge was found in error 2.36 feet; records have been corrected for this error.

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TABLE NO. 5.—*Highest and lowest annual stages of the Mississippi River and its principa tributaries, referred to present gauges*—Continued.

CUMBERLAND RIVER—NASHVILLE, TENN. (244 MILES FROM CAIRO).

[U. S. engineer gauge.*]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1878..			October 15, 16	*—0.40*
1882..	January 22	*55.30*		
1898..	January 23	38.80	July 14	1.50
1899..	February 11	40.60	October 10	.55
1900..	December 1	33.40	November 17, 18	.90
1901..	August 21	39.80	August 5	1.30
1902..	April 4	46.20	September 23	.93
1903..	March 9	40.60	October 30, 31	.88
1904..	March 27	37.60	October 6	1.00
1905..	March 14	31.40		

ILLINOIS RIVER—PEORIA, ILL. (160 MILES FROM MOUTH).

[U. S. Weather Bureau gauge; zero 454.66 feet above the Cairo datum plane.]

1890..			October 7	*2.6*
1898..	March 31	19.3	July 24	3.5
1899..	March 22	15.1	August 22–24, 27–29	3.4
1900..	March 16, 17	19.9	January 9	4.9
1901..	March 31	17.7	July 26–28	5.5
1902..	July 22	21.0	January 23–27	6.8
1903..	March 12, 13	19.3	August 3, 24–26	8.4
1904..	March 26, 29	*23.0*	September 16, 17	7.1
1905..	May 18, 19	17.9		

MISSOURI RIVER—KANSAS CITY, MO. (388 MILES FROM MOUTH).

[U. S. Weather Bureau gauge; zero 737.44 feet above the Cairo datum plane.]

1873..	July 5	19.3	December 6, 7	2.0
1874..	June 17–19	16.2	January 6	[a] —.1
			December 2	*1.5*
1875..	April 30	17.8	November 30	1.8
1876..	June 16	18.0	December 9	2.0
1877..	June 10	22.2	December 17	3.8
1878..	July 2, 3	19.8	January 12, 13	3.5
			December 13, 14	[b] 5.2
1879..	June 30	19.2	February 28, March 1	3.2
			December 14	4.0
1880..	July 10–12	16.7	November 23	[b] 2.0
1881..	April 30	26.3	December 31	3.0
1882..	July 3	19.2	January 5–9	2.3
			December 19–29	1.2
1883..	June 26	23.8	February 17, 23	[b] 5.0
1884..	July 5–7	[b] 17.2	November 29, December 15, 16	[b] 3.0
1885..	June 19	19.1	December 25–27	3.8
1886..	April 17	15.8	December 5–9	.2
1887..	April 1	20.2	December 27	1.8
1888..	July 2, 3	20.4	December 25–27	4.7
1889..	August 14	13.9	December 9, 15, 27, 28	3.2
1890..	June 11	17.2	January 8	.2
			December 11, 13, 14	3.1
1891..	July 1	23.1	January 7, 8	2.5
			November 24, 25	3.7
1892..	May 21	24.9	January 10	1.5
			December 14	2.7
1893..	April 14	18.1	December 19	3.1
1894..	June 20, 21	20.1	December 21	4.3
1895..	June 12	16.9	December 14	3.3
1896..	May 22	19.2	December 7	2.8
1897..	April 19	22.8	December 7, 8	2.0
1898..	June 12	21.5	December 12	4.0

[a] Probably caused by ice. Not used as lowest water for that reason.
[b] Gauge record is incomplete and possibly the period of extreme high or low is not included.

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TABLE No. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

MISSOURI RIVER—KANSAS CITY, MO. (388 MILES FROM MOUTH)—Continued.

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1899..	April 28	23.3	December 31	5.2
1900..	June 20	17.8	January 5, December 31	4.2
1901..	June 24, 25	19.4	January 11, December 18	3.7
1902..	July 14	23.2	December 15	3.5
1903..	June 1, 2	*a 55.0*	December 16	3.5
1904..	July 8	25.2	December 29–31	2.1
1905..	July 12	23.0		

MISSOURI RIVER—COLES CREEK, MO. (107 MILES FROM MOUTH).

[Missouri River Commission gauge; zero 433.97 feet above the Cairo datum plane.]

1892..	May 15	*96.76*		
1897..			December 24	*70.7*
1898..	June 17	90.65	December 13, 14	72.2
1899..	April 25, 26	90.6	December 31	71.9
1900*b*..	March 13	87.8	February 5–7	71.5

MISSOURI RIVER—HERMANN, MO. (108 MILES FROM MOUTH).

[U. S. Weather Bureau gauge; zero 502.17 feet above the Cairo datum plane.]

1878..			December 21, 22 *c*	*—0.75*
1898..	June 17	18.8	December 13	2.1
1899..	April 26, 27	18.9	February 3	1.6
			December 31	2.8
1900..	March 12, 13	16.2	February 6, 7	1.9
			December 25–28	3.8
1901..	April 17, 18	15.5	December 18	.8
1902..	July 3	18.0	January 29	1.7
			December 31	6.0
1903..	June 6	*d 29.5*	December 16	2.6
1904..	April 27	23.7	December 31	2.0
1905..	July 14	19.6		

OHIO RIVER—CINCINNATI, OHIO (504 MILES FROM MOUTH).

[City waterworks gauge; zero 447.62 feet above the Cairo datum plane.]

1881..			September 18	*1.92*
1884..	February 14	*71.06*		
1896..	March 28	61.1	October 5, 6	4.4
1899..	March 8	57.3	November 1, 2	3.4
1900..	November 30	40.0	October 21	3.1
1901..	April 26, 27	59.6	November 19	4.1
1902..	March 5	50.9	September 24, 25	3.9
1903..	....do	53.2	October 7, November 11–16	4.5
1904..	March 9	45.9	October 6, 7	3.3
1905..	March 13	48.3		

a High water of June, 1844=37 feet.
b Gauge discontinued after 1900.
c See Coles Creek for years 1895, 1896, 1897; records at Hermann doubtful for this period.
d High water of June, 1844, would read 35.6.

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TABLE No. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

OHIO RIVER—LOUISVILLE (UPPER), KY. (364 MILES FROM MOUTH).

[U. S. engineer gauge*; zero, 419.76 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1884..	February 16	*46.60*		
1895..			November 14, 16	*1.70*
1898..	March 30	36.20	September 26	3.50
1899..	March 10	32.80	September 5, 6	2.20
1900..	December 1	15.50	October 23	1.80
1901..	April 29	33.20	November 11	2.60
1902..	March 9	24.80	September 7–13	2.70
1903..	....do	28.50	December 20	2.80
1904..	March 28	22.90	October 7–9	2.00
1905..	March 14	22.00		

OHIO RIVER—LOUISVILLE (LOWER), KY. (364 MILES FROM MOUTH).

[U. S. engineer gauge*; zero, 392.85 feet above the Cairo datum plane.]

1872..			October 17, 18	[a] *1.60*
1884..	February 16	*72.00*		
1898..	March 30	62.00	October 8	4.30
1899..	March 10	58.30	November 2, 3	2.90
1900..	December 1	39.60	October 23	2.50
1901..	April 28	58.80	November 11	3.20
1902..	March 9	50.40	September 27–30	3.30
1903..	....do	54.30	November 14	3.90
1904..	March 28	48.50	October 9, 10	2.70
1905..	March 14, May 17	47.00		

OHIO RIVER—EVANSVILLE, IND. (188 MILES FROM CAIRO).

[U. S. engineer gauge; zero, 349.3 feet above the Cairo datum plane.]

1873..	December 20	34.60	October 19, 20	0.80
1874..	February 28	39.20	September 29, 30 [b]	.30
1875..	August 9, 10	41.90	September 22–25	2.50
1876..	January 31	43.30	December 20	3.80
1877..	January 23	41.50	October 14	1.00
1878..	December 18, 19	31.80	October 26–29	1.40
1879..	December 30, 31	37.80	October 28, 29	.40
1880..	February 21	42.10	October 10	2.00
1881..	February 19	38.90	September 16	.20
1882..	February 24	44.90	November 1, 2	4.00
1883..	February 19	47.80	September 24, 25	1.30
1884..	....do	[c] *48.80*	November 9, 11	1.20
1885..	January 23	37.50	October 17, 18	2.10
1886..	April 14	43.40	September 21	1.70
1887..	February 8, 9	43.20	November 4–6	.50
1888..	April 3, 4	35.20	August 17	3.00
1889..	February 25, November 30	29.00	October 18, 19	3.10
1890..	March 30, 31	44.40	August 5	3.00
1891..	March 2	42.80	November 4	1.90
1892..	April 25–28	38.20	November 8–13	1.10
1893..	February 24	41.80	September 4–6	1.60
1894..	February 19	31.80	September 13–15	.40
1895..	January 17, 18	35.50	November 7, 8	−.30
1896..	April 7, 8	38.00	September 22	2.90
1897..	March 2, 3	43.60	October 6	.40
1898..	April 2, 3	44.80	September 30, October 8	4.10
1899..	March 12	42.70	October 31, November 1	1.60
1900..	December 3	33.60	October 27	1.00
1901..	April 30, May 1	41.80	November 19–25	1.70
1902..	March 11, December 22	40.00	September 24	1.70
1903..	March 11	42.40	November 18	2.30
1904..	April 3, 4	39.80	October 13, 14	.90
1905..	March 17	37.40		

[a] As nearly as can be ascertained the low water of 1856 reads 1.0 foot on this gauge.
[b] Records received from the U. S. Weather Bureau.
[c] Taken from U. S. Weather Bureau publication of 1899. Gauge reading for this day published by same authority in 1891=48 feet.

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TABLE NO. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

OHIO RIVER—PADUCAH, KY. (45 MILES ABOVE CAIRO).

[U. S. Weather Bureau gauge; zero 300.46 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1884..	February 23	*54.25*		
1895..			October 30-November 4	*—0.70*
1898..	April 6	47.30	July 22, September 26, 27	3.50
1899..	April 4, 5	43.80	October 13–16, November 5–10	.50
1900..	March 15, 16	30.90	September 19, 20, October 6	1.60
1901..	May 1	39.40	November 18–21, 26–28	1.50
1902..	March 15, 16	39.70	September 17, 18, 23–26	1.40
1903..	do	47.60	December 18, 19	1.60
1904..	April 4	44.70	October 29—November 3	.20
1905..	March 17, 18	33.60		

OUACHITA RIVER—CAMDEN, ARK. (325 MILES FROM MOUTH OF RED RIVER).

[U. S. engineer gauge; zero 71.10 feet above the mean Gulf level.]

1882..	May 12	*46.00*		
1887..			August 29, 30[a]	*1.80*
1898..	January 25	33.60	September 12–14	2.93
1899..	January 18	39.10	October 20	2.35
1900..	March 4	26.20	August 27	2.95
1901..	April 23	33.90	August 28–September 7	2.85
1902..	December 1	36.20	July 23–26	3.95
1903..	February 20	39.60	December 9–14	2.33
1904..	June 12	33.60	September 21	1.95
1905..	May 9	41.60		

OUACHITA RIVER—MONROE, LA. (175 MILES FROM MOUTH OF RED RIVER).

[U. S. Weather Bureau gauge; zero 80.97 feet above the mean Gulf level.]

1874..		*49.10*		
1898..	February 12, 13	35.90	September 13–15	0.80
1899..	February 5–7	32.30	September 28–November 27	*.00*
1900..	May 2, 3	31.00	September 22–24	.50
1901..	May 7, 9	24.60	July 18–21, 24–31	*.00*
1902..	April 27, 28	35.10	September 11, 12	1.30
1903..	March 26–29	44.50	November 26–December 13	1.40
1904..	April 15–20	29.50	October 31–November 1, 5, 6	.30
1905..	May 31–June 2	44.00		

RED RIVER—FULTON, ARK. (508 MILES FROM MOUTH).

[U. S. engineer gauge*; zero 224.48 feet above the mean Gulf level.]

1876..	July 17	*55.75*		
1896..			September 19–25–October 20–22	*0.10*
1898..	May 11	27.90	November 7, 8	2.30
1899..	November 28	26.60	September 21	2.40
1900..	November 4	28.20	September 11	3.60
1901..	May 25	27.55	November 2	3.15
1902..	November 30–December 1	32.20	January 22, 23	3.30
1903..	March 14	31.15	December 16, 17	5.30
1904..	June 14	31.60	December 16–23	4.60
1905..	June 2, 3	31.50		

[a] On August 26, 1904, a new gauge was built at bridge of St. Louis Southwestern Railway, about 2¼ miles above former site. Gauge elevation unchanged.

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TABLE NO. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

RED RIVER—GARLAND, ARK. (450 MILES FROM MOUTH).

[U. S. engineer gauge; zero 208.16 feet above mean Gulf level.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1894..	March 24	*28.50*		
1896..			September 22–25	*—0.20*
1898..	May 11	27.70	November 8	1.35
1899..	November 28	20.60	October 31–November 1[a]	.95

RED RIVER—SHREVEPORT, LA. (320 MILES FROM MOUTH).

[U. S. engineer gauge *; zero 140.99 feet above the mean Gulf level.]

1892..	May 28	*35.70*	December 2–4	*—5.50*
1894..			November 8	.20
1898..	May 21	15.00	October 28–November 3	— .70
1899..	January 24	15.60	September 15	— .10
1900..	May 7, 8	15.00	November 6–9, 19–21	—1.00
1901..	June 7	16.40	January 25, 26	—1.00
1902..	December 15, 16	34.10	November 29, December 2–12, 16–19, 21–24	—2.00
1903..	March 22, 23	33.10		
1904..	June 24, 25	28.50	December 22, 23	—1.80
1905..	June 8, 9	33.6		

RED RIVER—ALEXANDRIA, LA. (110 MILES FROM MOUTH).

[U. S. engineer gauge *; zero 44.18 feet above the mean Gulf level.]

1881..			September 29	*—5.70*
1892..	June 12, 13	*36.25*		
1898..	January 23	17.40	November 8	—1.10
1899..	January 27	18.20	November 5, 6	—2.55
1900..	April 25	19.80	September 20	—1.22
1901..	April 26	14.60	December 1	—2.60
1902..	December 24	32.20	January 25	—2.15
1903..	March 28	36.05	December 10–12	—1.00
1904..	June 30	29.50	December 22–25	—1.70
1905..	June 16, 17	35.43		

ST. FRANCIS RIVER—BRIDGE OF ST. LOUIS, IRON MOUNTAIN AND SOUTHERN RAILWAY (MEMPHIS BRANCH) (194 MILES FROM MOUTH).

[M. R. C. gauge; zero 176.5 feet above sea level by railroad levels.]

1897..	April 4–6	*41.60*		
1898..	April 17–19	34.10	January 1–5	1.10
			September 29	3.00
1899..	April 11–15	30.30	October 24–28, October 31–November 20	.50
1900..	March 20–22	15.30	November 17, 18	1.00
1901..	April 20	14.50	November 3–11	— .05
1902..	December 31	16.80	September 18–22	.00
1903..	April 2, 3	32.90	October 23–November 16	.40
1904..	April 25, 26	23.10	December 1–5, 20–23	1.05
1905..	June 1–3	18.5		

[a] This gauge was discontinued December 31, 1899.

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TABLE NO. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

TENNESSEE RIVER—CHATTANOOGA, TENN. (450 MILES ABOVE MOUTH).

[U. S. Weather Bureau gauge; zero 651.90 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1867..	March 11	*58.60*		
1883..			September 19	*0.00*
1898..	September 5	24.60	June 15	1.60
1899..	March 22	40.00	October 6, 7, 27, 28, November 22	.80
1900..	February 15	24.30	September 13	1.00
1901..	December 31	37.40	November 22	2.10
1902..	January 2	40.80	September 2, 3, October 30, 31	1.20
1903..	April 11	31.80	September 30–October 7, 28–30	.6
1904..	March 25	22.10	October 25–27	.09
1905..	February 11	22.4		

TENNESSEE RIVER—FLORENCE, ALA. (300 MILES FROM CAIRO).

[U. S. engineer gauge[a]; zero 418.04 feet above the Cairo datum plane.]

1878..			September 18	*−0.76*
1897..	March 19	*32.20*		
1898..	January 20, 27–29	18.80	June 14, 19	.87
1899..	March 20	25.20	September 26, October 10, 29–November 6.	− .10
1900..	April 20	19.52	September 13–15	.07
1901..	August 22	18.92	November 22–25	.80
1902..	March 29	21.70	November 4	− .40
1903..	March 6	18.82	October 5–7	− .50
1904..	March 27, 28	17.20	October 28–November 3	− .50
1905..	February 12, 13	16.70		

TENNESSEE RIVER—JOHNSONVILLE, TENN. (139 MILES FROM CAIRO).

[U. S. Weather Bureau gauge; zero 343.3 feet above the Cairo datum plane.]

1882..		*a 48.00*		
1892..	April 14, 15	*b* 35.40	October 29–November 3	1.10
1893..	February 22, 25, 26	33.60	October 19	1.00
1894..	February 13, 14	31.10	November 3–5	.10
1895..	January 19	25.50	October 28–November 1	.00
1896..	April 12	28.30	September 27, October 20, 21, 31–November 7.	.30
1897..	March 24	*48.00*	October 6–20	− .30
1898..	January 24	29.10	June 16, July 16	1.40
1899..	March 31	39.70	October 11–13, November 3–7	.00
1900..	June 30	29.50	September 17, 18	.60
1901..	August 26	27.60	November 27–30	.60
1902..	April 2, 3	35.60	September 15–17, November 4–7	.40
1903..	March 11	33.70	October 6–8, 10, 27, 28, 31–November 2.	.00
1904..	March 30	28.10	October 26–November 4	− .90
1905..	February 14, 15	24.0		

a High-water mark.

b Corrected to new gauge established June 1, 1892. Correction to reduce readings prior to 1892 to present gauge not considered reliable.

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TABLE No. 5.—*Highest and lowest annual stages of the Mississippi River and its principal tributaries, referred to present gauges*—Continued.

WABASH RIVER—MOUNT CARMEL, ILL. (190 MILES FROM CAIRO).

[U. S. Weather Bureau gauge; zero 397.86 feet above the Cairo datum plane.]

Year.	Highest.		Lowest.	
	Day.	Gauge reading.	Day.	Gauge reading.
		Feet.		*Feet.*
1875..	August 7	*23.30*		
1896..			November 7–23	−0.20
1898..	March 30, 31	27.00	September 4, 5	1.30
1899..	January 23	19.50	September 30–October 18	.30
1900..	March 14, 15	19.00	October 30, 31, November 1	1.20
1901..	March 19	17.50	October 5–12	.00
1902..	December 25	17.00	September 25, 26	1.00
1903..	March 12	22.30	October 2, 3	.40
1904..	April 2	27.10	November 9–12	.50
1905..	May 19	16.20		

WHITE RIVER—JACKSONPORT, ARK. (360 MILES FROM MOUTH).

[U. S. engineer gauge *.]

1872..			December 24	*−1.10*
1890..	March 14	*33.35*		
1898..	March 30	32.50	January 10	2.15
			September 11, 12	2.20
1899..	May 12	29.00	October 7–10	.40
1900..	November 26, 27	22.30	August 23	.40
1901..	March 15	24.50	October 3–11	− .75
1902..	December 19	25.55	August 21	− .45
1903..	March 12	29.77	November 27	.05
1904..	March 29	29.60	November 19–21	− .35
1905..	May 25, 26	29.10		

WHITE RIVER—CLARENDON, ARK. (134 MILES FROM MOUTH).

[M. R. C. gauge; zero 158.9 feet above the Cairo datum plane, by railroad levels.]

1887..			November 22	*4.07*
1890..	March 20	*36.65*		
1898..	April 5	35.40	September 12	9.35
1899..	May 21	29.55	October 9–16	5.75
1900..	March 16	25.45	August 29	5.75
1901..	March 26	26.75	October 10, 11	4.35
1902..	December 30	28.30	August 28, November 6–8	5.40
1903..	March 20	32.63	December 11	5.90
1904..	April 8	29.60	November 24–26	5.25
1905..	June 3	29.90		

YAZOO RIVER—YAZOO CITY, MISS. (65 MILES FROM MOUTH).

[U. S. Weather Bureau gauge; zero 93.34 feet above the Cairo datum plane.]

1875..				*−4.80*
1882..		*36.50*		
1898..	April 26–28	24.40	November 9, 10	−1.00
1899..	April 9–14	25.80	October 11–28, November 14–24	−2.60
1900..	April 30	23.00	October 11, 12	− .70
1901..	January 11	18.30	November 16–18	−1.80
1902..	April 21, 22	26.60	October 30–November 24	−2.10
1903..	April 5–8	28.70	November 1–11	−2.50
1904..	April 26–29	22.60	November 16–21, 26–30	−3.00
1905..	March 20–22, 29, April 4	21.50		

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TABLE No. 6.—*Results of discharge observations.*

MISSISSIPPI RIVER, THEBES, ILL. (44.5 MILES ABOVE CAIRO).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
				Area.		Depth.										
	Cape Girardeau M. R. C.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.							
1904.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cubic feet.*				
Apr. 29.....	33.0	31.50	+0.7	99,548	102,018	38.3	39.2	52.2	2,600	.....	7.24	721,227	Meter...	18	60	I, mild.
Apr. 30.....	33.8	32.10	+ .8	101,613	102,523	39.1	39.4	51.5	2,600	+ 505	7.62	774,152	....do...	20	59	III, light.
May 1.....	34.1	32.30	+ .3	104,688	105,078	40.3	40.4	52.5	2,600	+2,555	7.69	805,122	....do...	19	74	II, light.
May 2.....	34.0	32.45	− .1	104,881	104,881	40.3	40.3	52.9	2,600	-- 197	7.36	771,534	....do...	21	67	XI, light.
May 3.....	33.9	32.33	− .1	105,827	106,139	40.7	40.8	54.1	2,600	+1,258	7.43	786,089	....do...	22	86	I, light.
May 4.....	33.4	32.10	− .5	103,259	104,169	39.7	40.1	53.4	2,600	−1,970	7.29	753,262	....do...	24	67	V, light.
May 5.....	32.9	31.75	− .5	101,506	103,326	39.0	39.7	55.2	2,600	-- 843	6.78	688,310	....do...	24	68	V, brisk.
May 6.....	32.0	31.00	− .9	100,371	104,141	38.6	40.0	51.8	2,600	+ 815	6.36	638,036	....do...	19	67	Do.

The Thebes discharge section is the same as that used in 1903, and is about opposite center of street immediately below the depot of the Chicago and Eastern Illinois Railroad. Thebes is about 9 miles below Cape Girardeau, Mo.

The zero of Cape Girardeau gauge is 324.97 feet above the Cairo datum plane.

The local gauge is about 450 feet above the discharge section; its zero is 320.47 feet above the Cairo datum plane; it was set by the bridge engineers.

The datum line used for computing the datum areas reads 32.45 feet on the local gauge.

Price meters Nos. 23 and 25 were used singly.

For additional notes see pages 88-91.

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TABLE NO. 6.—*Results of discharge observations*—Continued.

MISSISSIPPI RIVER, COLUMBUS, KY. (22 MILES BELOW CAIRO).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
				Area.		Depth.										
	Columbus M. R. C.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.							
1904.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
Apr. 3	43.68	.....	+0.26	195,820	196,568	62.9	63.1	87.7	3,115	.....	7.51	1,471,063	Meter...	9	71	XI, strong to light.
Apr. 4	43.84	.....	+ .24	[a] 195,224	.....	.....	.....	.....	.....	.....	7.41	1,447,354	Double float.	17	.....	X, light.
Apr. 5	43.92	.....	+ .10	194,627	194,627	62.5	62.5	90.1	3,115	−1,941	7.72	1,501,554	Meter...	16	91	IV, light to brisk.
Apr. 6	43.82	.....	− .04	195,120	195,431	62.6	62.7	88.9	3,115	+ 804	7.24	1,413,057	...do	16	81	X, light.
Do	43.80	.....	.....	[a] 195,056	.....	.....	.....	.....	.....	.....	7.15	1,395,407	Double float.	16	.....	
Apr. 7	43.56	.....	− .27	192,587	193,708	61.8	62.2	88.0	3,115	−1,723	7.04	1,357,590	Meter...	16	82	IV, light.

[a] Interpolated.

Zero of M. R. C. gauge is 286.76 feet above the Cairo datum plane; the readings given correspond to time of discharge observations; the "Rise or fall" is computed from the 8 a. m. readings. Datum is taken at 43.92 feet on this gauge for computing datum areas.

The discharge section is practically the same as that of 1903 and is opposite the town of Columbus.

Haskell meter 1/1 and Price meter 34 were used; results are the mean of the two meters.

For additional notes see pages 88–91.

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TABLE No. 6.—*Results of discharge observations*—Continued.

MISSISSIPPI RIVER, MEMPHIS, TENN. (231 MILES BELOW CAIRO).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
				Area.		Depth.												
	Memphis U. S. E.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.									
	Feet.	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*	*Cub. feet.*	*Cub. feet.*				
1904. Apr. 9..	38.6	.....	−0.9	153,690	.....	71.9	.....	118.5	2,137	.....	9.66	1,510,980	[a]107,082	[b]1,618,012	Meter and float.	.....	87	.....

[a] 89,828 cubic feet per second of this over-bank discharge was through the openings in Frisco Railroad, from bridge to St. Francis levee.
[b] If two soundings in the main river, questioned by the observer, are rejected, this total discharge would be 1,581,865 cubic feet per second.

Zero of gauge is 208.97 feet above the Cairo datum plane.
Price meter No. 43 was used in main river and surface floats in over-bank discharge.
The discharge section is about 1,000 feet above the Memphis bridge.
For additional notes see pages 88-91.

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TABLE No. 6.—*Results of discharge observations*—Continued.

MISSISSIPPI RIVER, HELENA, ARK. (307 MILES BELOW CAIRO).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
				Area.		Depth.												
	Helena, U. S. E.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.									
1904.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*	*Cub. feet.*	*Cub. feet.*				
Apr. 6.	43.20	.....	+0.65	181,626	.....	37.0	.....	.....	4,903	.....	6.30	1,143,909	1,310	1,145,219	Meter	15	70	Calm.
Apr. 9.	45.55	.....	+ .75	193,188	203,288	39.4	41.5	94.8	4,903	.....	6.85	1,323,452	1,518	1,324,976	.....do.....	15	94	X, strong.
Apr. 10.	46.30	.....	+ .75	196,046	202,500	39.8	41.1	96.8	4,927	− 788	6.80	1,334,561	1,584	1,336,145	.....do.....	15	98	IX, brisk.
Apr. 11.	46.90	.....	+ .60	a202,343	.....	41.0	.....	.....	4,936	.....	6.81	1,377,123	1,637	1,378,760	Doublefloat.	18	.....	Calm.
Apr. 12.	47.23	.....	+ .40	207,358	209,237	41.9	42.3	96.6	4,945	+6,737	6.76	1,402,959	1,666	1,404,625	Meter	15	121	XI, brisk.
Apr. 13.	47.48	.....	+ .25	209,271	209,914	42.3	42.4	96.6	4,945	+ 677	6.71	1,403,989	1,687	1,405,676	Doublefloat.	16	116	VI, light.
Apr. 14.	47.61	.....	+ .15	206,719	206,719	41.8	41.8	97.8	4,945	−3,195	6.82	1,409,980	1,699	1,411,679	Meter	16	109	Calm.
Apr. 15.	47.62	.....	+ .02	a206,769	.....	41.8	.....	.....	4,945	.....	6.61	1,368,204	1,699	1,369,903	.....do.....	15	.....	Calm.

a Interpolated.

Soundings of April 7 mainly used for cross section of April 6.
Over-bank discharge was measured on April 10. All over-bank discharges derived from this measurement.
Zero of gauge 161.98 feet above the Cairo datum plane. The datum line for computing datum areas was at 47.61 feet on the gage.
The gauge readings are given for time of discharge observations; the rise or fall is computed from the 8 a. m. readings.
Haskell meter No. 11 and Price meter No. 22 were used; Results are the mean of the two meters.
The discharge section was the same as that used in 1903, about ¼ mile below Helena, Ark. Over-bank discharge was on the right bank.
For additional notes see pages 88–91.

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TABLE No. 6.—*Results of discharge observations*—Continued.

MISSISSIPPI RIVER, CHICOT, ARK. (432 MILES BELOW CAIRO).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
				Area.		Depth.										
	Arkansas City M. R. C.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.							
1904.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
Apr. 11.....	45.8	150.88	+0.7	218,641	231,642	50.8	53.8	67.4	4,305	.....	5.63	1,231,458	Meter ..	14	93	X, strong to calm.
Apr. 12.....	46.5	151.52	+ .7	219,620	229,866	51.0	53.4	68.9	4,305	−1,776	5.84	1,288,740	...do	18	108	II, brisk.
Apr. 13.....	47.1	152.10	+ .6	218,828	226,577	50.8	52.6	65.4	4,305	−3,299	5.96	1,304,919	...do	17	104	IV, brisk.
Apr. 14.....	47.6	152.68	+ .5	[a]221,325	.....	51.4	.....	.....	4,305	.....	5.91	1,307,795	Double float.	17	.....	Do.
Apr. 15.....	48.0	153.08	+ .4	[a]223,533	.....	51.9	.....	.....	4,305	.....	6.10	1,362,128	Meter ..	17	.....	IV, light to calm.
Apr. 16.....	48.4	153.40	+ .4	224,910	227,062	52.2	52.7	68.9	4,305	+ 485	6.08	1,368,226	...do	18	95	III, brisk.
Apr. 17.....	48.7	153.67	+ .3	222,201	223,191	51.6	51.8	68.2	4,305	−3,871	6.15	1,367,548	...do	17	108	III, light.
Apr. 18.....	48.9	153.80	+ .2	[a]223,915	.....	52.0	.....	.....	4,305	.....	6.06	1,356,584	...do	17	.....	Calm.
		153.82	.....	[a]224,291	.....	52.1	.....	.....	4,305	.....	6.17	1,383,174	Double float.	22	.....	Do.
Apr. 19.....	49.0	153.89	+ .1	226,087	226,080	52.5	52.5	66.9	4,305	+2,889	6.09	1,377,484	Meter ..	17	106	III, light.
Apr. 20.....	49.0	153.90	.0	226,598	226,598	52.6	52.6	70.4	4,305	+ 513	6.19	1,403,078	...do	18	116	IV, brisk.
Apr. 21.....	49.0	153.88	.0	225,065	225,151	52.3	52.3	68.8	4,305	−1,442	6.11	1,375,508	...do	17	101	III, brisk.

[a] Interpolated.

Zero of Arkansas City gauge is 116.44 feet above the Cairo datum plane. Arkansas City is 6 miles below discharge section.
Local gauge used is high-water gauge No. 105, which is about 300 meters below discharge section. Zero is 18.13 feet above the Cairo datum plane.
Haskell meter 1/1 and Price meter No. 34 were used; results are the mean of the two meters.
The discharge section is the same as that used in 1903, and is 232 meters above prominent right angle in levee below Chicot, Ark., and 20 meters below church on left bank.
For additional notes see pages 88–91.

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TABLE NO. 6.—*Results of discharge observations*—Continued.

MISSISSIPPI RIVER, VICKSBURG, MISS. (600 MILES BELOW CAIRO).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
				Area.		Depth.										
	Vicksburg, Miss. U. S. E.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.							
1904.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
Apr. 23.....	46.65	.....	+0.05	206,739	.....	78.1	.....	157.0	2,635	.....	6.72	1,382,080	Meter...	13	89	VI, brisk.

Zero of gauge is 66.04 feet above the Cairo datum plane.
Haskell meter 1/1 and Price meter 34 were used in discharge measurement. Results are the mean of the two meters.
The discharge section is at same place as in 1908; it is 365 meters below the Refuge Oil Mill below Kleinston.
For additional notes see pages 88–91.

MISSISSIPPI RIVER, RED RIVER LANDING, LOUISIANA (765.3 MILES BELOW CAIRO).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
				Area.		Depth.										
	Red River Landing, Louisiana, U. S. E.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.							
1904.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
Apr. 29....	43.70	.....	+0.05	203,288	.....	48.7	.....	.....	4,174	.....	5.01	1,018,438	Meter...	18	112	X, light.
Apr. 30....	43.70	.....	.00	203,288	203,288	48.7	48.7	80.7	4,174	.....	4.95	1,006,548	....do...	18	112	V, light.
May 1.....	43.60	.....	−.05	203,111	203,528	48.7	48.8	81.0	4,174	+240	4.94	1,004,399	....do...	19	98	Calm to XII, brisk.

Water area of April 30 is used for April 29.
Zero of gauge is 8.57 feet above mean Gulf level.
The gauge readings are given for time of discharge observations; the rise or fall is computed from the 8 a. m. readings.
Haskell meter No. 1/1 and Price meter No. 34 were used in discharge measurements. Results are the mean of the two meters.
The discharge section is the same as that used in 1908 and is just below Red River Landing.
For additional notes see pages 88–91.

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TABLE No. 6.—*Results of discharge observations*—Continued.

ATCHAFALAYA RIVER, SIMMESPORT, LA. (4 MILES BELOW HEAD).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
				Area.		Depth.										
	Barbre Landing, Louisiana M. R. C.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.							
1904.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
Apr. 26.....	40.50	40.50	+0.30	55,820	56,238	48.6	49.0	88.9	1,148	.....	4.21	235,040	Meter ..	9	39	X, brisk.
Apr. 27.....	40.70	40.70	+ .20	54,953	55,137	47.9	48.0	88.9	1,148	−1,096	4.22	232,178	...do....	10	68	Do.
Do.....	.....	40.78	.....	[a] 55,246	.....	48.1	.....	.....	1,148	.....	4.21	232,719	Double float.	10	.....	XI, light.
Apr. 28.....	40.90	40.86	+ .20	55,988	55,988	48.8	48.8	89.9	1,148	+ 851	4.30	240,688	Meter ..	10	57	X, light.
Do.....	.....	40.88	.....	[a] 56,011	.....	48.8	.....	.....	1,148	.....	4.24	237,728	...do....	10	.....	
Do.....	.....	40.90	.....	[a] 56,034	.....	48.8	.....	.....	1,148	.....	4.28	237,228	Double float.	8	.....	

[a] Derived from soundings taken in a. m.

Zero of M. R. C. gauge at Barbre Landing, La., is 3.91 feet above mean Gulf level. Local gauge was set to read the same as Barbre Landing gauge on April 26.
Haskell meter No. 1/1 and Price meter No. 34 were used. Results are the mean of the two meters.
The discharge section was the same as that used in 1903, 30 meters below store at Simmesport Landing.
For additional notes see pages 88–91.

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TABLE No. 6.—*Results of discharge observations*—Continued.

ATCHAFALAYA RIVER, NEITA, LA. (18 MILES FROM HEAD).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
				Area.		Depth.										
	Melville, La., Weather Bureau.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.							
1904.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
Dec. 22	3.40	.....	+0.20	18,061	19,216	22.0	23.2	28.0	821	.....	0.593	10,717	Double float	8	25	V, 4 to 7 miles.
Dec. 23 a. m.	3.60	.....	+ .20	17,962	18,951	21.9	22.9	29.0	821	−265	.680	12,202	do	8	29	IV, 4 to 7 miles.
Do	3.60	.....	.....	[a] 17,962	.....	.....	.....	.....	821	.....	.589	10,586	do	8	.....	Do.
Dec. 24 a. m.	3.80	.....	+ .20	[a] 18,136	.....	.....	.....	.....	822	.....	.638	11,578	do	8	.....	
Do	3.80	.....	.....	[a] 18,136	.....	.....	.....	.....	822	.....	.699	12,677	do	8	.....	
Dec. 25 a. m.	3.91	.....	+ .10	[a] 18,223	.....	.....	.....	.....	823	.....	.692	12,609	do	8	.....	
Dec. 25 p. m.	3.92	.....	.....	[a] 18,231	.....	.....	.....	.....	823	.....	.642	11,700	Rod float	8	.....	
Dec. 27 a. m.	4.80	.....	+ .80	18,956	18,956	22.9	22.9	30.8	827	+ 5	.691	13,106	do	8	23	X, 4 to 7 miles.
Do	4.90	.....	.....	[b] 19,039	.....	.....	.....	.....	827	.....	.778	14,806	do	8	.....	X, 5 to 9 miles.
Dec. 28 a. m.	5.50	.....	+ .70	[b] 19,535	.....	.....	.....	.....	829	.....	.897	17,529	do	8	.....	
Do	5.70	.....	.....	[b] 19,701	.....	.....	.....	.....	830	.....	.943	18,572	do	8	.....	

[a] Interpolated. [b] Used areas of December 27, corrected for change in stage.

The discharge section was about ¼ mile below Neita post-office, about 18 miles from head of the Atchafalaya River and about 12 miles above Melville, La.
The readings of Melville gauge have been tabulated; its zero is 0.1 foot below mean Gulf level. The line for computing datum areas was taken at 4.8 feet on this gauge.
Rod floats were nearly full depth, double floats mid depth. Float ranges were 200 feet apart.
For additional notes see pages 88-91.

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TABLE NO. 6.—*Results of discharge observations*—Continued.

MISSISSIPPI RIVER, CARROLLTON, LA. (957 MILES BELOW CAIRO).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
				Area.		Depth.										
	Carrollton, La., U. S. E.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.							
1904.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
Apr. 23.....	15.70	.....	+0.30	178,862	179,757	80.9	81.3	111.9	2,212	.....	6.10	1,090,891	Meter	11	66	V, strong.
Apr. 24.....	15.75	.....	+ .15	177,377	178,261	80.2	80.6	111.9	2,212	−1,496	6.19	1,097,935	.....do	11	52	V, brisk.
Apr. 26.....	16.00	.....	+ .02	172,890	173,222	78.2	78.3	109.0	2,212	−5,089	5.99	1,035,708	.....do	12	76	XI, brisk.
Apr. 27.....	16.10	.....	+ .05	172,100	172,211	77.8	77.9	109.7	2,212	−1,011	5.80	997,655	.....do	11	54	XI, light.
Apr. 28.....	16.14	.....	+ .10	172,687	172,709	78.1	78.1	108.7	2,212	+ 498	6.25	1,079,227	Double float	10	49	Calm.
Apr. 29.....	16.15	.....	− .05	170,612	170,612	77.1	77.1	108.7	2,212	−2,097	6.20	1,057,218	Meter	11	55	Nearly calm.
Apr. 30.....	16.10	.....	.00	171,875	171,986	77.7	77.8	108.7	2,212	+1,374	6.05	1,039,854	.....do	11	62	Do.
May 1.....	16.12	.....	.00	168,502	168,568	76.2	76.2	107.7	2,212	−3,418	6.06	1,021,931	.....do	11	68	Do.
May 2.....	16.01	.....	− .15	171,832	172,143	77.7	77.8	108.2	2,212	+3,575	6.06	1,041,579	.....do	11	52	Do.
May 3.....	15.92	.....	.05	167,020	167,529	75.5	75.8	108.2	2,212	−4,614	6.11	1,020,596	.....do	11	65	IV, Light.

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TABLE No. 6.—*Results of discharge observations*—Continued.

MISSISSIPPI RIVER, CARROLLTON, LA. (957 MILES BELOW CAIRO).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
				Area.		Depth.										
	Carrollton, La., U. S. E.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.							
1904.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
Dec. 15	0.30	.....	−0.30	145,801	178,880	70.7	80.9	94.2	2,063	+11,351	1.29	187,492	Meter	10	43	X, light.
Dec. 28	− .06	.....	−1.55	142,677	176,499	69.2	79.8	93.5	2,063	− 2,381	1.19	170,007	do	10	46	IX to X, strong.
Dec. 29, a. m.	− .05	.....	− .15	143,692	177,498	69.6	80.2	93.5	2,063	+ 994	1.20	171,840	do	10	46	II to III, light.
Dec. 29, p. m.	− .09	.....	.....	[a] 142,780	.....	.....	.....	.....	2,063	.....	1.16	165,602	do	10	.....	XI to XII, light.
Do	− .09	.....	.....	141,950	175,834	68.8	79.5	94.0	2,063	− 1,659	1.26	179,322	do	10	49	XII, light.
Dec. 30, a. m.	− .05	.....	− .15	143,731	177,532	69.7	80.3	93.8	2,063	+ 1,698	1.28	183,466	do	10	49	Calm to XII, light.
Dec. 30, p. m.	.02	.....	.....	[a] 143,875	.....	.....	.....	.....	2,063	.....	1.23	177,176	do	10	.....	I to II, light.
Do	.15	.....	.....	[a] 144,144	.....	.....	.....	.....	2,063	.....	1.10	158,079	do	10	.....	Calm to I, light.
Dec. 31, a. m.	.20	.....	+ .30	144,219	177,504	69.9	80.2	94.5	2,063	− 28	1.26	180,660	do	10	46	II to III, light.
Dec. 31, p. m.	.35	.....	.....	143,562	176,538	69.6	79.8	93.5	2,063	− 966	1.18	168,184	do	10	43	IV to V, brisk.
1905.																
Jan. 2	.50	.....	+ .25	[b] 143,871	.....	.....	.....	.....	2,063	.....	1.42	204,125	Double float	.....	.....	X to XII, light to strong.

[a] Interpolated.

[b] Area of December 31, corrected for change of stage.

Zero of Carrollton gauge is 0.131 foot below the mean Gulf level. Datum line for computing datum areas is taken at 16.15 feet on the gauge.

The gauge readings are given for time of discharge observations; the rise or fall is computed from the 8 a. m. readings.

All the high-water meter discharges were by Haskell meter No. 11, except on April 29 and May 3, when Price meter No. 22 was also used, results being the mean of the two meters. The low-water meter discharges were observed with the Price meter No. 25 and Haskell meter No. 1, results being the mean of the two meters, except on December 15 and 28, when Haskell meter No. 1 was used alone.

The discharge section is the same as that used in 1903, and is 1¼ city blocks above Carrollton avenue.

For additional notes see pages 88–91.

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TABLE No. 6.—*Results of discharge observations*—Continued.

ARKANSAS RIVER, LITTLE ROCK, ARK. (176 MILES ABOVE MOUTH).

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
				Area.		Depth.										
	Little Rock, Ark., U. S. E.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.							
1904.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cub. feet.*				
June 10 a. m.	29.2	9.88	+0.50	46,168	46,664	29.7	30.0	45.0	1,553	.....	9.00	415,426	Meter and double float.	10	29	V, light.
June 10 p. m.	29.2	9.87	.....	46,230	.....	29.8	.....	.....	1,553	.....	9.25	427,699	.....do.....	10	.....	Do.
June 11 a. m.	29.4	10.05	+ .20	44,190	44,345	28.4	28.6	44.0	1,553	−2,819	9.25	408,644	.....do.....	11	30	IV, light.
June 11 p. m.	29.4	.....	.....	44,220	.....	28.5	.....	.....	1,553	.....	9.95	440,089	Double float	8	.....	Do.
June 12 a. m.	29.4	10.15	.00	46,226	46,226	29.8	29.8	40.0	1,553	+1,881	9.37	433,288	.....do.....	9	42	Do.
June 12 p. m.	29.3	10.08	.....	47,236	47,345	30.4	30.5	40.0	1,553	+1,119	9.02	425,954	Meter and double float.	12	29	Do.
June 13 a. m.	29.1	9.82	− .30	47,143	47,655	30.4	30.7	41.5	1,553	+ 310	8.83	416,284	Double float	8	49	
June 13 p. m.	29.0	9.77	.....	47,969	48,559	30.9	31.3	41.0	1,553	+ 904	8.30	398,313	Meter	10	35	III, light.
June 13 p. m.	29.0	9.76	.....	47,954	.....	30.8	.....	.....	1,553	.....	8.24	394,967	.....do.....	10	.....	Calm to III, light.
June 14 a. m.	28.7	9.62	− .40	50,870	51,698	32.8	33.3	40.0	1,553	+3,184	7.59	385,956	.....do.....	9	31	III, light.
June 14 p. m.	28.5	9.59	.....	47,810	48,680	30.8	31.4	40.0	1,553	−3,013	7.40	354,047	.....do.....	9	37	Calm to VII, light.
June 15.....	28.1	9.22	− .60	48,340	49,785	31.1	32.1	39.0	1,553	+1,105	6.95	235,900	.....do.....	9	49	VII, light.
July 15	26.2	6.41	+ .20	43,606	43,622	28.0	28.0	36.2	1,556	.....	6.46	281,575	.....do.....	8	42	VIII, light.
July 16	26.4	6.42	+ .20	45,278	45,278	29.1	29.1	38.2	1,556	+1,651	6.40	289,505	.....do.....	11	67	VI, light.
July 16	.....	6.41	.....	[a]45,258	.....	29.1	.....	.....	.....	.....	6.14	277,979	.....do.....	11	.....	Do.
July 17	26.2	6.32	− .20	44,250	44,406	28.4	28.5	36.8	1,556	− 867	6.08	269,123	.....do.....	11	49	VIII, light.
July 17	.....	6.29	.....	[a]44,208	.....	28.4	.....	.....	.....	.....	6.08	268,559	.....do.....	10	.....	Do.
July 18	25.9	6.17	− .30	41,965	42,354	27.0	27.2	37.0	1,556	−2,052	5.15	216,209	.....do.....	11	48	VIII, brisk.
July 18	.....	6.05	.....	[a]41,778	.....	26.8	.....	.....	.....	.....	5.72	239,065	Double float	10	.....	Calm.
July 18	.....	6.02	.....	[a]41,732	.....	26.8	.....	.....	.....	.....	5.53	230,904	.....do.....	9	.....	Do.
July 19	25.4	5.68	− .50	43,097	44,248	27.7	28.4	36.0	1,556	+1,894	5.87	252,970	Meter	11	44	VI, light.
July 19	.....	5.60	.....	[a]42,972	.....	27.6	.....	.....	.....	.....	5.33	229,010	Double float	10	.....	

[a] Interpolated.

The discharge section was about 780 meters below the Choctaw Railroad bridge.
The zero of the U. S. engineer gauge is 241.532 feet above the Cairo datum plane.
The local gauge was at the discharge section. In June its zero was 259.08 feet above Cairo datum plane, datum line for computing datum areas was taken at 10.15 feet on this gauge. In July the zero was 260.13 feet above the Cairo datum plane, datum line taken at 6.42 feet.
On June 10, 11, and 12 velocities were measured in part by both methods.
Price meter No. 43 was used in June and Haskell meter No. 10 was used in July.
For additional notes see pages 88–91.

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TABLE No. 7.—*Meter ratings.*

HASKELL METERS.

Number of wheel.	Frame.	Date.	A.	B.	Mean error of observation.	Mean error of A.	Mean error of B.	Number of observations.	Length of base.	Limits of observed velocity per second.	Locality.
		1904.							*Feet.*	*Feet.*	
1	A	May 2, 3	1.71709	+0.10641	±0.1268	±0.0131	±0.0360	48	200	1.7 to 9.5	Red River Landing, La.
1	A	Aug. 9–16	1.73715	+ .16646	± .1006	± .0086	± .0307	45 pairs	200	.8 to 13.2	St. Louis, Mo.
1	A	Weighted means[a]	1.73106	+ .14089							
1	A	Aug. 9–15	1.69360	+ .25859	± .0740	± .0125	± .0392	32 pairs	200	2.9 to 9.4	Do.
1	B	Aug. 16, 17, 19, 20[b]	1.32184	+ .34825	± .0668	± .0814	± .0443	28 pairs	200	.5 to 8.5	Do.
10	B	Aug. 9, 10, 16[c]	2.16831	+ .65440							Do.
11	B	May 6, 7[d]	2.08112	+ .22511	± .1059	± .0172	± .0422	35	200	1.6 to 8.4	Westwego, La.
11	B	Aug. 11–15	2.25605	+ .31076	± .1082	± .0153	± .0357	24 pairs	200	1.5 to 12.8	St. Louis, Mo.

[a] Used for Columbus, Chicot, Vicksburg, Red River Landing, and Simmesport.
[b] Used for Carrollton, low water.
[c] Used for Little Rock, July.
[d] Used for Helena and Carrollton, high water.

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TABLE No. 7.—*Meter ratings*—Continued.

PRICE METERS.

Number of meter.	Date.	A.	B.	Mean error of observation.	Mean error of A.	Mean error of B.	Number of observations.	Length of base.	Limits of observed velocity per second.	Locality.
	1904.							*Feet.*	*Feet.*	
22	May 6-7	3.67641	+0.39388	±0.0628	±0.0204	±0.0278	32	200	2.0 to 8.4	Westwego, La.
22	August 11-15	3.90017	+ .30241	± .0625	± .0212	± .0256	22 pairs	200	1.6 to 9.8	St. Louis, Mo.
	Weighted means[a]	3.78280	+ .34480							
23	May 14[b]	3.4115	+ .5579	± .3179	± .0746	± .1181	23	102.5	1.5 to 10.1	West Memphis, Ark.
23	August 9-10	3.88595	+ .31454	± .1368	± .0327	± .0517	31 pairs	200	1.7 to 11.9	St. Louis, Mo.
	Weighted means	3.76700	+ .35340							
25	May 13, 14[b]	3.42598	+ .37459	± .3250	+ .0768	± .1183	28	102.5	1.4 to 10.4	West Memphis, Ark.
25	August 12-20	3.70426	+ .82250	± .1610	± .0324	± .0462	46	200	2.1 to 12.3	St. Louis, Mo.
	Weighted means	3.6681	+ .7635							
	1905.									
25	January 17-18[c]	3.73641	+ .34348	± .0330	± .0336	± .0136	18 pairs	200	.6 to 8.5	New Orleans, La.
	1904.									
34	May 2, 3	4.05517	+ .14833	± .1172	± .0241	+ .0243	64	200	.5 to 9.5	Red River Landing, La.
34	August 9, 10, 16	3.79112	+ .4999	± .0682	± .0250	± .0292	21 pairs	200	1.7 to 10.5	St. Louis, Mo.
	Weighted means[d]	3.9285	+ .29128							
43	May 14	3.7554	+ .2672				13	102.5	2.6 to 9.9	West Memphis, Ark.
43	June 20-22	3.15718	+ .89926				21	100	3.8 to 11.4	Do.
	Weighted means[e]	3.30674	+ .3662							
43	August 16-17	3.6235	+ .7346				31	200	3.9 to 13.9	St. Louis, Mo.

[a] Used for Helena and Carrollton, high water.
[b] Used for Thebes.
[c] Used for Carrollton, low water.
[d] Used for Columbus, Chicot, Vicksburg, Red River Landing, and Simmesport.
[e] Used for Little Rock, June.

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APPENDIX 1 E.

REPORT OF ASSISTANT ENGINEER WILLIAM GERIG UPON DREDGING OPERATIONS ON THE MISSISSIPPI RIVER BETWEEN HEAD OF THE PASSES AND THE MOUTH OF THE OHIO RIVER, AND CARE AND REPAIR OF DREDGING PLANT, APRIL 1, 1904, TO APRIL 30, 1905.

MEMPHIS, TENN., *May 7, 1905.*

CAPTAIN: I have the honor to submit the following report pertaining to dredges and dredging for the period April 1, 1904, to April 30, 1905:

The dredging plant and dredging operations were under the direction of Assistant Engineer F. B. Maltby for the period April 1, 1904, to November 20, 1904, and since that time have been under my direction.

The project of maintaining a low-water channel by means of dredging has been fully explained in previous reports.

CARE OF PLANT.

During the year the following plant, when not in operation, has been cared for at West Memphis, Ark.:

Dredges: *Beta*, *Gamma*, *Delta*, *Epsilon*, *Zeta*, *Iota*, *Kappa*, and *Henry Flad*	8
Steamboats: *Mississippi*, *Minnetonka*, *Sachem*, *Choctaw*, *Nokomis*, *Wynoka*, *Leota*, *Search*, *Patrol*, *Vulcan*, *Venus*, *Mercury*, and *Mars*	13
Pile sinkers: *Nos. 61*, *971*, *981*, *982*, *985*, and *984*	6
Barges: *Nos. 208*, *211*, *215*, *228*, *041*, and *051*	6
Quarter boat: *Illinois*	1
Small flush deck flat	1
Calking flat	1
Sectional docks	6

Pile sinker *No. 61*, barges *Nos. 208*, *211*, *215*, *228*, and small flush deck flat were condemned June 22, 1904, and were either destroyed or sold.

The small tenders *Mercury* and *Vulcan* have been used as fleet tenders during the lay-up season.

Steamer *Mississippi*, used exclusively as an inspection boat by the Mississippi River Commission, left the fleet for the fall inspection trip October 24, 1904, and returned on November 28. She again left the fleet for the spring inspection trip March 28, 1905, and returned to the fleet April 20, where she was laid up.

Steamer *Patrol*, used in connection with surveys, gauges, and observations, left the fleet May 26, 1904, for Paducah, Ky., where the hull was rebuilt and other extensive repairs were made. She returned to the fleet February 27, 1905. She left the fleet again April 28, 1905.

During the year the following boats, belonging to the dredging plant, have been used on other works as follows:

Steamer *Vulcan* left the fleet April 5, 1904, for discharge measurements on the Mississippi River, returning to the fleet on May 31, 1904.

Steamer *Mars* returned to the fleet June 9, 1904, from discharge observations at various points on the Mississippi River; and again left the fleet, with quarter boat *Illinois*, on August 30, 1904, for work connected with surveys, gauges, and observations, and returned to the fleet February 21, 1905, where she was laid up.

Steamer *Search* left the fleet June 10, 1904, for services with the Board of Engineers on the Illinois River and returned July 3, 1904.

Steamer *Venus* left the fleet July 13, 1904, for services with Waterways from Lockport, Ill., to St. Louis, Mo., returning September 7, 1904.

The dredge *Delta*, in tow of the steamer *Sachem*, left the fleet May 19, 1904, for Louisville, Ky., where both boats were docked, hulls sand blasted and painted, and returned to Cairo July 5, 1904, where they were cared for till the dredging season.

Steamer *Minnetonka*, in tow of the steamer *Wynoka*, left the fleet May 26, 1904, for Paducah, Ky., where extensive repairs were made to the *Minnetonka*, and returned, under her own steam, to the fleet September 20, 1904.

Dredge *Gamma*, in tow of the steamer *Wynoka*, left the fleet July 18, 1904, for Louisville, Ky., where both boats were placed in the docks, hulls sand blasted and painted, and returned to the fleet January 10, 1905.

On May 26, 1904, a party was sent to Caruthersville, Mo., to care for the season's supply of fuel, consisting of 23 barges, which was received June 2, 1904.

Miscellaneous.—The general work of care of the plant at the fleet consists in arranging and keeping the plant in position; cleaning hulls; bringing supplies and material from the wharf at Memphis; checking, assorting, and caring for property, and general office work.

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SUBSISTENCE.

All employees are furnished subsistence in kind. During the past thirteen months 93,752 rations were served, at a cost of $0.47789 each, including the cost of cooks, waiters, and all necessary labor in caring for quarters.

REPAIRS TO PLANT.

In addition to the more important items of repairs mentioned below in connection with each piece of plant, many minor repairs, such as grinding valves, repacking steam-pipe joints, painting smokestacks, small woodwork repairs, and tightening propelling wheels, were made where necessary. The boilers of all boats were inspected and tested in the same manner as provided by the United States steamboat inspection laws.

The total amount of this class of work is quite a large item of cost.

Dredge Beta.—At the beginning of this period this boat was being prepared for work in South Pass. New tubes were placed in the feed-water heater. Repairs to pontons were completed. All the pontons were sand blasted and painted. After the changes and alterations had been made it was found that this dredge would not be needed in South Pass. The dredge remained at the fleet till October, 1904, when she was shipped up for field use, but never put in service. Numerous minor repairs were made.

Dredge Gamma.—This dredge was not in commission during the year. The hull was sand blasted and painted two coats of red lead. The hull at the stern was extended. The old heater from the *Wynoka* was put onto the dredge and installed. Canvas was placed on the boiler-deck guards and painted. New breeching was made for the boilers. New stumps for the smokestacks are being made. Some repairs were made to the woodwork where necessary.

Dredge Delta.—The hull was sand blasted and painted. An extension was built to the stern of the hull for blacksmith shop, thus avoiding the use of a plunder barge. Work of installing the new suction tanks was completed. The high-pressure cylinder of the main pumping engine was bored out and the piston head overhauled. A new piston rod for the high-pressure cylinder of the main pumping engine was made. Ventilating hatches were cut in the deck and coamings were put around them. A new brass bushing was placed on the main shaft near pump. The pump-casing liners were repaired. The telescoping casting in the discharge pipe of starboard jet pump, which was broken, was repaired. The suction head was strengthened at the points where the hoisting cables are attached. The asbestos tile which formed the walls around the boilers was broken, and the walls have been entirely rebuilt with clay tile. The boilers have been overhauled and tested. New smokestacks are being built. The bottom of the suction and discharge pipes at the flanges in the hold of the dredge are badly worn and are being repaired by patches. Numerous minor repairs have been made. New wire for electric lights is being placed.

Dredge Epsilon.—An extension was built to the hull at the stern to be used for blacksmith and carpenter shop instead of using a plunder barge. The main deck hatches have been enlarged and additional hatches for ventilation were placed. New smokestacks were made. New exhaust pipes from the heaters to the stacks were made. Two new sheets were put in the boilers. The steel deck in the boiler room was renewed. The furnaces were overhauled and rebuilt. New grate bars were made. New eccentric and strap for starboard pumping engine were procured and placed. The main pump was overhauled and liners renewed where necessary. New piston rod and valve stem for the electric-light engine were made. The wooden nosing around the hull was repaired. The roof was repaired and painted. The pontons were sand blasted and painted. Several drawbars were repaired.

Dredge Zeta.—The hull was extended at the stern. The deck hatches were enlarged. Additional hatches for ventilation were cut in the deck and coamings placed around them. The runner of the main pump was converted into one of the inclosed type. New cast-iron rings for the throat of the sand pump were procured in the rough, and the machine work was done at the fleet. Minor repairs were made to the main pump in December, 1904, with a view of using the dredge again during that season. It is thought that this pump will last another season without any more repairs, although the runner is considerably worn. One new sheet is being put in the boilers. New smokestacks were made and erected. The steel deck in the boiler room is being renewed. New piston head and piston rod for the high-pressure engine of the jet pump were made. Eight of the pontons have been sand blasted and painted with coal tar.

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Dredge Iota.—The deck hatches were enlarged and coamings placed around them. A drain tank was built in the hold and all drain pipes were connected to it. A new spud, built up out of small timber, was made. The first outrigger aft of the wheel on each side was altered to allow more clearance for water. The boiler feed pipes were renewed. New fire-door liners and grate bars were procured. The furnace was rebuilt. The feed-water heater was overhauled. The electric-light engine was overhauled. The broken piston was removed from the steam cylinder of the jet pump. The piston rods of jet pumps were turned off. The valves of the jet pumps, condenser pumps, and propelling engines have been overhauled. The runner of the sand pump, which was worn out last season on "Presidents Island Crossing," is being removed from the shaft, so that a new one can be placed. The discharge pipe in the hold was badly worn on the bottom at the flanges. This pipe was turned over so that the worn part would come on top; where the pipe was worn through it was repaired by means of patches. The wheels are being rebuilt. A new waterway was placed on the roof. The roof was repaired and painted. The woodwork of the cabin was repaired where necessary. Material for new smokestacks has been procured. The pontons were sand blasted and painted with coal tar.

Dredge Kappa.—The main-deck hatches were enlarged and coamings placed around them. Iron stairways were placed in the hatches leading to the hold. The wooden nosing was repaired. A waterway was put around the roof. The roof was painted. The wheels are being rebuilt. Ventilating hatches were cut in the top of the wheelhouses. The port derrick, which was broken, was repaired. Cast-iron rings for the throat of the sand pump were procured and placed. The shrouds on the sand pump have been set out about three-sixteenths inch to decrease the clearance caused by wear. A new liner was placed in the upper half of the casing. The flanges on the branch steam pipe of the propelling engines were reriveted. The valves and brasses of the propelling engines were overhauled. The propelling engines were very carefully lined. The main steam pipes over the boilers were altered so as to provide better drainage. A set of fire-door liners was procured and installed. The furnaces were rebuilt. The material for the smokestacks was procured. The ash chute was lined with fire brick. The boiler feed pumps and jet pumps were overhauled. The outlet of the drain tank was enlarged. The pontons were sand blasted and painted with coal tar. The broken flanges on the pontons were removed and the sections are being joined by butt straps. The deck of the kitchen was calked. Numerous repairs were made to the steam and water pipes, etc. Minor repairs were made to the woodwork of the cabin.

Dredge Henry Flad.—Main-deck hatches were enlarged and coamings placed around them. Iron stairways were placed in the hatches leading to the hold. The wooden nosing has been repaired. New cast-iron rings for the throat of the sand pump were procured and placed. Liners in the bottom half of the casing were renewed. The shrouds on the sand pump were set out one-quarter inch to decrease the clearance caused by wear. The packing of the sand pump was renewed. New joints were made between high and low pressure cylinders of main engines. The heaters were overhauled. The exhaust pipes were reriveted. The main steam pipes over the boilers were altered so as to provide better drainage. The feed-water pipes were raised to permit main steam-pipe alterations. New joints of pipe were put in Snowden heaters. A bag in one of the boilers was set up and the seams were recalked. The seams of safety-valve flanges were recalked. The gage cocks were lowered. New fire-door liners and grate bars were made. Furnace was rebuilt. The ash chute was repaired and lined with fire brick. The piston valves of the jet pumps were overhauled and the rods of same were turned up. A new crank was made for the ice machine. The armature of the dynamo was taken out, sent to St. Louis, repaired, and replaced in position. The boiler feed pumps were overhauled. The capstan engines were overhauled. The outlet of the drain tank was enlarged. A new waterway was placed around the roof. The roof was painted. The deck of the kitchen was calked. The wheels are being repaired. The pontons have been sand blasted and painted. The broken flanges on the pontons were removed and are being replaced by butt straps. Minor repairs were made to the woodwork of the cabin.

Steamer Mississippi (Mississippi River Commission).—Repairs were made to the woodwork of the main and boiler decks, roof, and texas floor. The roof was partly recovered with canvas and painted. The cabin was painted where necessary. The main and boiler decks were painted. The hull was painted above the light water line. The wheel was overhauled and painted. The cracked nozzles of both propelling engines were patched. The starboard copper branch pipe was brazed. A new stuffing-box gland was made for the fire pumps. A new steam trap, for disposing of the water condensing from the heating system, was installed. A new and

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larger auxiliary boiler was placed and a smokestack made for same. Two new sheets were put in the main boilers. The flame bed and furnaces were rebuilt. The boilers were covered. Covering of the steam pipes was repaired. Two new swinging stages were made. A considerable amount of repairing was done to the steam and water pipes, all of which are becoming old.

Steamer Minnetonka.—The hull was rebuilt by contract at Paducah, Ky. The cabin received extensive repairs. New roof was placed. The wheel was rebuilt. The pipe work, which was removed in building the hull, was replaced. New smokestacks were built and erected. New casings and umbrellas for stacks were made. Doctor pump was overhauled. The cabin, wheel, casings, fire front, and chimneys were painted.

Steamer Sachem.—The outside of the cabin, the decks, the wheel, stacks, casing, and fire front have been painted. A new roof of asbestos was placed. The boat was placed in the docks at Louisville, Ky., where the hull was sand blasted and painted two coats of red lead. New casings and new umbrellas for stacks are being made. The pump plungers were turned off, and the pumps were overhauled. The ice plant was overhauled. The auxiliary steam line was overhauled. New fire-front liners were made, and the furnaces were overhauled.

Steamer Choctaw.—The work of installing the new heaters was completed. The electric-light plant was overhauled. Trusses for supporting the boiler deck in the coal room were placed. The wheel was repaired and painted. The plungers of the boiler feed pumps were turned up and the pumps were overhauled. Stacks, casing, fire front, and main deck have been painted. New casing and umbrellas for stacks are being made. New fire-front liners were made and placed, and the furnaces were rebuilt. New bitts are being made. The wooden nosing around the hull is being repaired. New fenders have been made.

Steamer Nokomis.—New roof of asbestos was laid. The wheel was completed and painted. The work of iustalling the heaters was completed. A traveler for handling the cylinder heads of the main engines was made and placed. The pumps were overhauled. The pipe covering was repaired. The wooden nosing around the hull was repaired. New fenders and bitts have been made. The electric-light engine was overhauled. The main deck, casing, fire front, and smokestacks have been painted. The boiler-deck nosing was repaired. New fire-door liners were procured and placed. The furnace was overhauled. New casings and umbrellas for smokestacks were made. A considerable amount of repairing was done to the steam and water pipes. Steam was raised on this boat, and, with the dredge *Epsilon* in tow, she departed for Louisville, Ky., on April 28, 1905, where the outside of the hull will be sand blasted and painted.

Steamer Wynoka.—The new feed-water heaters were installed. A curved section of main steam pipe was procured and erected. The outside of the hull was sand blasted and painted. A bogchain, broken in transit from Louisville, was repaired. The plungers of the boiler feed pumps were turned up. New fire-front liners were procured and placed. The furnaces were overhauled. The roof, chimneys, casings, fire front, deck, and wheel were painted. The drains of the heaters were enlarged. The suction shoes are being moved aft, opposite the pumps; formerly the shoes were located immediately aft of the boilers where the cinders were thrown overboard, and the cinders were drawn into the pump. Considerable work was done grinding valves, making new joints, and repairing pipes.

Steamer Leota.—The work of installing the new heaters was completed. A new roof of asbestos was laid. New fire-front liners were made and put in. The furnaces were overhauled. The armature of the electric-light engine was sent to St. Louis for repairs. The pump plungers were turned off, and the pumps were overhauled. A broken stay rod of the starboard pitman was repaired. It has been impossible to hold a joint under the valve chamber of the propelling engines of all five of these boats, and a scraped joint is being tried. Such a joint has been made on one engine of this boat, but as yet has not been tested. New bitts and fenders were made. Woodwork of cabin was repaired. The hull was painted inside, also outside above the light-load line. The wheel, deck, stacks, fire front, and casings have been painted. Considerable work was done, such as overhauling crank-pin and crosshead brasses, renewing pipes, and making new joints. New and larger casings are being made for the smokestacks.

Steamer Search.—New fire-door liners were procured and placed. The furnace was rebuilt. New steel cylinder timbers were put in position. The wheel was rebuilt. The machinery and pipe work, which was removed in rebuilding the hull, was replaced. New safety valves were put on the boilers. New heaters were made and placed. The roof, cabin, stacks, casings, and fire front were painted. New doctor valves were procured and placed.

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Steamer Patrol (surveys, gauges, and observations).—The hull was rebuilt by contract. New steel cylinder timbers were built by contract and were placed. The wheel was rebuilt and the machinery and pipe work, which was removed in rebuilding the hull, was all replaced at Paducah, Ky.

Steamer Vulcan.—A new smokestack was made. The boat was docked; the outside of the hull was sandblasted and painted with coal tar. The roof was repaired and painted. The woodwork of the cabin, wheel, nosing, and main deck was repaired. New fire-front liners were made and placed. The furnace was overhauled. Both pitmans were repaired. The doctor and all the machinery was overhauled.

Steamer Venus.—New smokestacks and breeching were made and put up. The wheel, nosing, deck, and woodwork of the cabin were repaired. Two new flues were put in the boiler. The casing around the boiler was renewed and the brickwork of the furnace rebuilt. New splash bulkhead was put on. The cabin, inside and out, wheel, stack, and hull above light water line were painted. The pipes connected to the suction shoes were repaired. New crosshead was procured in the rough, and the machine work was done at the fleet.

Steamer Mercury.—A new splash bulkhead was put on. The tiller arm of the port rudder was repaired. The wheel was repaired. The breeching was repaired. The pipes connected to the suction shoes were repaired. The boiler feed pump received new liners. All of the machinery was overhauled. The fenders and stanchions were repaired. The cabin, inside and out, the hull above the light load line, deck, roof, and smokestacks were painted.

Steamer Mars.—The boiler was burnt and a new sheet for repairing this was procured and is being made ready. A new ash pan was made. Minor repairs were made to the machinery.

Quarter boat Illinois.—This boat was placed in the dry docks at the fleet and the hull repaired and calked. New canvas roof was put on and painted.

Pile sinker No. 981 was placed in the dry dock, the hull repaired, calked, and renewed where necessary.

Pile sinker No. 982 was placed in the dry dock, the hull repaired where necessary, and calked. New liners were placed in the feed pumps.

Pile sinker No. 984 received a general overhauling.

New barges.—Two new barges, Nos. 041 and 051, 20 feet by 80 feet by 4-foot depth of hold, were built for use at fleet.

Sectional docks.—Six sectional docks were built for use in repairing and painting hulls of pile sinkers, small tenders, and pontons. The dimensions of each are 36 by 12 by 4½ feet depth of hold and 30 feet in the clear between the trunks

Buildings and grounds.—New blacksmith and machine shop was erected. Concrete piers were placed to carry new lathe, planer, punch and shears, pipe-cutting machine, radial drill, and steam hammer. An engine was erected. The foregoing machinery and two smaller lathes were erected and connected. The saw was connected to the shop engine. A wood lathe was erected. The fences were repaired. The railroad track was raised and ballasted. The boiler house and carpenter shop were raised.

DREDGING OPERATIONS.

The season of 1904 is remarkable for the large amount of dredging required, the actual time employed dredging being 4,263.48 hours with six dredges. The largest amount of dredging previously done during any one year was in 1899, when five dredges were employed 3,259.30 hours. The amount of river covered was from Nolans (76) to Andersons (359), being 283 miles.

The Cairo gauge reached 11 feet August 14, and there was 9 feet reported on the Point Pleasant Crossing (82). This stage was exceeded, for a short time, only twice during the balance of the year, the latter part of August and the first part of October. The river fell almost continuously till December 25, when the gauge reached 3.10 at Cairo.

The required channel was maintained at all crossings except during a short time at Presidents Island (233), and during this time there was a practical steamboat channel of at least 8 feet.

In the beginning of the season there were two channels at Presidents Island Crossing, one near the upper end of the reef, where the material is a hard and compact gravel, and the other near the lower end, where the material is principally sand. On account of the character of the material in the two channels, the lower channel was chosen for improvement, and dredging was done there by the *Epsilon* September 2 to 8, and by the *Iota* September 10 to 17. The results show that the wrong channel was selected, as the cuts were rapidly obliterated. At an inspection made on the 17th, while the *Iota* was at work, less than 9 feet was found alongside the dredge

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where a cut 18 feet deep had been made a few hours previously. While this effort to open the lower channel was being made, the river continued to fall, reducing the depth in the upper channel to less than 9 feet from about September 17 to 22. A rise in the river restored the depth. On September 23 the *Iota* began dredging in the upper channel. Progress was slow on account of the character of the material, but a channel of the required dimensions was obtained by the end of the month, and remained till October 15, when the river had fallen to 4 feet on the Memphis gauge. The *Zeta* was then placed there, commenced work on the 16th, and continued till the 22d. Since the survey showed that very little had been accomplished, as there was no more water over the crossing than before dredging was begun by the *Iota*, the *Zeta* was ordered to the bank, and remained there until November 8, when dredging was resumed. Work was completed November 14, and the dredge went to the bank.

The dredge *Iota* was placed on the crossing again on December 8, and worked till the 28th, when the sand pump was completely worn out, and the dredge was ordered to West Memphis. Very little was accomplished by this dredge at this place.

Dredge Beta.—This dredge was put in commission for work at Presidents Island Crossing at the beginning of October, but as she was not needed in the field, she was put out of commission again about October 15, 1904.

Dredge Gamma.—This dredge was at Louisville during the season. The channel in the Ohio River, during the entire dredging season, was not of sufficient depth to permit the Gamma to return to the Mississippi River.

Dredge Delta.—This dredge in tow of the steamer *Sachem* left Cairo August 22, and reached the vicinity of Point Pleasant (82) on the same day. The pumps and machinery were shipped up, rubber sleeves were put on the pontons, and dredging was begun on August 27, 1904. Owing to delays on account of washing boilers and adjusting engines, continuous dredging was not begun till the 28th, and continued with slight interruptions, due to main engine running hot, till September 3, when about thirteen hours were lost in repairing and packing the engines. All of the 4th and twelve hours of the 5th were also consumed in this work, and dredging was not resumed till 1.30 p. m. on the 5th. On September 6 a casting on the telescopic elbow of the starboard jet pump was broken, but dredging was continued without the use of this pump till the completion of the work contemplated, at noon September 7, when dredging was discontinued.

Surveys showed a 13½-foot channel over this bar, the dredged cut being sharply defined.

Dredging was resumed on September 10, at 5 p. m., over a reef in the same crossing, but considerably lower down, and entirely separate from the reef first dredged over. This work was completed on September 14, and dredging was discontinued. Surveys showed a good 11-foot channel over the crossing. The dredge lay at the bank awaiting orders till September 19, minor repairs being made to the machinery and the dredge cleaned up. On September 19 she was taken to Joe Eckles bar (92) and began dredging on the evening of the same day. The work contemplated was completed on September 28, and the dredge went to the bank. On completion of the work there was a 16-foot channel in line with the current.

The dredge was taken back to Point Pleasant Crossing, where she lay at the bank awaiting a lower stage. As the river fell the first channel dredged showed a small amount of filling, but was still well defined. Dredging was resumed October 10, at 4.20 p. m., and continued without serious interruption till October 16, when the starboard suction pipe, on the bottom, near the forward bulkhead, was worn entirely through. This wear was caused, to a very large extent, by dredging in gravel at Presidents Island Crossing last year. Temporary repairs were made with a loss of only one and one-half hours, and dredging continued till the morning of October 20, when the dredge was moved out of the channel to wash boilers. Dredging was resumed on October 22, at 6.15 p. m., and continued till 9 a. m. October 25, when work was completed. The dredging over this bar during the last three days was done to widen the channel at the lower end, in order to make it easier to enter with a tow. There was a good 13-foot channel at the completion of the work, and this channel was maintained during the remainder of the season.

The channel across the lower reef had worked down and showed signs of shoaling, and the dredge was placed there on October 25. Dredging was begun at 4.30 p. m. and continued till about 7 a. m. October 27, when the work contemplated was completed, and the dredge went to the bank awaiting orders. There was a good 13½-foot channel over this reef, which was maintained during the remainder of the season. The dredge remained at the bank till December 23, when she was moved to Nolans Crossing (76), over which reef there was 9 feet. After some delay in getting coal to the dredge work was begun at about 11 a. m. December 24. Dredging was continued with a single crew until 10 p. m. December 30, when the work contemplated was finished.

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Since the river was rising rapidly the dredge was ordered to the fleet at West Memphis, Ark., where she arrived January 3, 1905, and was laid up.

Dredge Epsilon.—This dredge was placed in the lower crossing at the head of Presidents Island Crossing (233) on September 2, but owing to trouble with ponton line dredging was not begun till about noon September 3. Dredging was continued without serious interruptions till 9 a. m. September 8, when the dredge was ordered to Corona. The dredge reached Corona (203) on September 9, and began dredging at 7 p. m. of the same day. Dredging was continued without interruption until September 16, when the work contemplated was completed and the dredge went to the bank. The results at this bar were satisfactory. On September 19 the dredge was taken to Pecan Point (194), where she began dredging on September 20. The work contemplated was finished September 24. Surveys made September 26 showed a wide, straight channel with not less than 14 feet of water. The dredge remained at the bank till October 13, when she was taken to Walts Landing (198) and began dredging at 12.30 p. m. of the same day. Dredging was continued without interruption until 5 a. m. on the 20th, when boilers were cleaned. At this time there was 13 to 17 feet in the dredged cut, with 10½ feet in the crossing above the cut. Dredging was resumed at 6.30 a. m. on October 23, and the work contemplated was completed that day. The dredged cut on this bar was nearly 3,000 feet long.

The dredge was again taken to Corona (203) October 24, where dredging was begun at 3 p. m. and was continued with minor interruptions for repairs till 9.30 a. m. October 31, when the engine ran hot, due to the excessive play on the main shaft. Repairs were made and dredging resumed on November 2. The work contemplated was completed November 4, and the dredge went to the bank, where she remained till November 30. On that day she was placed on the upper end of the Pecan Point Crossing (195). Dredging was begun at 12.15 a. m. of December 1, and the work was finished at 6 a. m. December 5, when the dredge went to the bank.

At the completion of dredging there was a good 13-foot channel at this place, and not less than 10 feet was found here during the balance of the season.

As the crossing at Walts (198) was shoaling, the dredge was again placed there on December 8, and began dredging at 3 p. m. of that date. Dredging was continued without interruption till about 4 p. m. December 11, when the work contemplated was finished and the dredge went to the bank. This crossing again showed signs of shoaling, and dredging was resumed at 12.30 a. m. December 22 and continued with a single crew till about 9.30 a. m. December 31, when the work was finished and the dredge went to the bank. The dredge was ordered to the fleet at West Memphis, Ark., where she arrived January 1, 1905, and was laid up.

Dredge Zeta.—This dredge was placed in commission on August 24 and towed to the Memphis Bridge, where the stacks were erected. She left for Corona (203) August 27 and arrived August 28, and dredging was begun at 6 p. m. August 30. Dredging was continued without interruption till 10.35 a. m. September 4, when work was discontinued to wash boilers. Surveys made at this time did not show very favorable results. Where the dredging was done there was a deepening, but not a marked or continuous channel over the reef. It was believed at that time, and proved to be correct, that the dredged cut was improperly located, too far down stream.

On September 9 this dredge was sent to Last Chance Crossing (168), and dredging was begun at 6.35 a. m. September 10. The work to be done consisted in dredging through a short reef, and this was completed on September 12, when the dredge was towed to Hales Landing. The results at this crossing were satisfactory, a good channel of not less than 10½ feet in depth being secured, which was maintained till about December 20.

Dredging was begun on September 13, opposite Osceola, in a channel which leaves the shore at New Haven (162), returning again to the same shore about Hales Landing. This channel was dredged, as it was feared that the rapid caving below New Haven might shoal the channel down the shore. Dredging was continued without interruption till September 17, when the work was completed and the dredge went to the bank. There was 15 feet along the dredged cut and not less than 10½ feet in the channel, but it was not used, the pilots preferring to use the old channel downshore. The dredge was towed to O'Donnells (149) on September 20, where it was thought dredging would be required. This crossing, however, remained good, and the dredge was sent to Presidents Island Crossing on October 14; arrived there and commenced dredging in the upper crossing October 16, 1904. Dredging continued till 2.25 p. m. October 22, when boilers were cleaned.

On October 23 the steamer *Leota*, with a loaded coal barge, ran aground, and on the same day the steamer *Titan* grounded on the opposite side of the channel. In releasing the *Titan* one of the ponton couplings was broken, and twelve of the pon-

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tons floated about 2 miles before they were caught. The barge grounded by the *Leota* was released without injury by partly unloading it.

Since this dredge was accomplishing so little in this crossing, she was sent to the bank. Surveys made at this time showed that though a few holes were made and lumps thrown up, there was no more water over the crossing than before any dredging was done.

Dredging was again resumed on November 8, and continued till 5.30 p. m. November 14, when the dredge went to the bank. On November 21 this dredge was towed to West Memphis, Ark., and remained there till November 30, when she was put out of commission.

In all five cuts were made at Presidents Island Crossing, and progress was very slow.

Upon examining the sand pump on this dredge it was found that the runner was almost worn-out. Temporary repairs were made so that the dredge could be used again should the occasion arise.

Dredge Iota.—This dredge was sent to Presidents Island Crossing (233) September 9 to complete the work undertaken by the *Epsilon* on the lower channel. Dredging was begun at 6 p. m. September 10, and was continued with minor delays, due to repairs to condenser and feed pipe and cleaning boilers, until 8 p. m. September 14, when a piston head in the low-pressure cylinder of the jet pump was broken. An entire day was spent in unsuccessfully attempting to remove the head from the rod, and on September 16 dredging was resumed, operating the jet pump in its damaged condition. Dredging was abandoned at 7 p. m. on the 17th, as there was evidence of rapid shoaling in the dredged cut. The dredge was then placed on the gravel reef at the upper end of the crossing September 23, and after consuming six hours in sinking piles dredging was begun at 8 p. m. About nine hours were consumed in sinking piles on September 24 and twelve hours in cleaning boilers on the 28th and 29th. Work was completed October 1, at which time eleven cuts had been made, with a possible depth of 13 feet down the dredged cut. Progress was very slow, owing to the fact that this reef is entirely of hard, compact gravel, with the remains of many wrecks and much drift in it.

The dredge was taken to Peters Crossing (272) on October 11, and dredging was begun on the forenoon of October 14, and continued without interruption till 5 a. m. October 16, when the work was completed.

The work done at this crossing was very satisfactory. A survey made October 11 shows a possible channel of 9½ feet. At the point selected for dredging there was only about 7 feet of water, with a distance over the reef of about 800 feet. A survey made October 17, one day after dredging, shows a channel through the reef with not less than 15 feet of water and 250 feet in width between the 11-foot contour lines. This is another good example of quick and efficient dredging, as these results were obtained in only 43½ hours from the time the dredge left the bank till she returned to the same point.

The dredge left Peters Crossing October 26 and arrived at Montezuma Crossing (311) October 27. Dredging was begun October 29 and continued without interruption till October 31, when the work was completed and the dredge departed upstream. Upon completion of work there was 14½ feet of water in the dredged channel, 200 feet wide, which was maintained till November 21.

The dredge reached Polks Landing (266) November 4, and dredging was begun on the 7th. The work contemplated was completed November 8. A survey made November 9 showed 13 feet on this crossing.

The dredge left Polks at 8.25 a. m. November 11, and arrived at the foot of Fleeces Crossing (244) at 1.45 p. m. on the 12th, and remained at the bank awaiting a lower stage until November 20, when dredging was begun in the upper channel through the reef. The work was completed November 23. Thirteen cuts were made in all, aggregating 7,400 linear feet. There was 13½ feet in the crossing upon completion of the work.

On November 26 this crossing had filled up so there was only 8 feet in the dredged channel, but there was 9½ feet in the lower channel through this reef. Since it was evident that the upper channel could not be maintained, the dredge was placed in the lower channel and commenced dredging November 29. The work was continued without interruption until completion, at 12 25 p. m. December 2, when the dredge was taken to the bank.

The channel at this place was maintained during the balance of the season.

The dredge left Fleeces at 11.40 a. m. December 7 and arrived at Presidents Island at 5.45 p. m. of the same day, but the channel there being very narrow, and the wind blowing hard, no attempt was made to place the dredge that day. The dredge left the bank at 11.20 a. m. December 8, and was in position to begin at 1.05

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p. m., but, owing to delays caused by grounding of the steamer *Chisca* and afterwards the *Kate Adams*, dredging was not begun until 8.15 a. m. December 12. Dredging was continued till 8.30 a. m. December 13, when both shrouds of the main pump runner gave way. Repairs were made, and dredging was resumed at 12.40 a. m. of the 14th and continued till 1.30 a. m. of the 20th, when it was found that a hole had been worn in the bottom of the discharge pipe, inside the hold of the dredge. Temporary repairs were made, and dredging was resumed at 7 a. m. December 21, but work was again delayed by grounding of the pontons, caused by breaking one of the cables. The pontons were floated off in separate sections, coupled up, and dredging was resumed at 9.40 p. m. of the 21st and continued till 2 a. m. December 28, when the dredge was disabled by breaking off two flukes of the main pump runner. The dredge was ordered to West Memphis, where she arrived at 8.45 a. m. of the 29th, and was laid up.

The desired results were not produced by this dredge on this crossing, owing to the extremely difficult material.

Dredge Kappa.—This dredge was placed in commission and left upstream at 7 a. m. on August 19, and arrived at Pecan Point (195) August 20. After cleaning boilers and packing the feed-water heater, the dredge went into position and began dredging at 6.30 a. m. August 22, and continued without serious interruption until the work was completed, at 6.15 p. m. August 26. The work at this place was successful, since a survey made August 27 shows a 12-foot channel over the crossing, where there was only 9 feet before dredging was done.

This dredge was placed before a survey was made, as a survey party was not available at that time. It was apparent, from a survey made later, that, although a channel was promptly made, the dredging should have been done at least one-half mile downstream. The first channel was soon obliterated, and the dredge was placed in the lower channel and dredging resumed August 30. Dredging was continued without interruption till completion, at noon September 3. As the crossing showed some signs of shoaling above the dredged channel, work was resumed at 5 p. m. September 5 and continued till 10.15 p. m. September 7.

Surveys showed a marked improvement in the channel, but owing to the rapidly caving shore just above the crossing, which deposited a large amount of material in the channel, it was constantly changing, and was dredged three times during the season. However, at no time was there less than 9 feet in the channel.

The dredge departed upstream September 8, and arrived at Wrights Point September 10. She was placed on foot of Island 21 Crossing (133), and dredging was begun about 5 p. m. September 11, and continued without serious interruption till 4 a. m. September 15. The results were entirely satisfactory, as a good 12-foot channel, easy to run, was made, which was maintained till October 20.

The dredge went to Pecan Point (195) on September 15, and on September 18 departed for Polks (266), where she arrived September 19. Dredging was begun here September 23, and was completed September 26, with a loss of five hours, due to breaking a bolt in the main engine. The reef here was short and easily handled, and at completion of work there was a 15-foot channel. Owing to a rise in the river, the dredged cut largely disappeared, though no dredging was required till November 7. The dredge left Polks (266) October 3, and arrived at Andersons (359) October 5, where she remained at the bank awaiting a lower stage till October 10. On this date dredging was begun and continued without interruption till October 13, when one and three-fourth hours were lost from breaking one of the universal ponton couplings in the discharge pipe line. The work contemplated was finished October 15, when there was a 13-foot channel over the crossing.

The dredge lay at the bank till October 20, when dredging was resumed near the upper end of the cut first made. Two hours and fifteen minutes were lost on this day from breaking a universal coupling in the discharge pipe line. The work was completed October 22. The dredge remained at the bank till November 7, when dredging was again resumed in this channel. The lower end had narrowed somewhat, and this was widened. The work contemplated was completed November 9, and the dredge went to the bank to await a lower stage. There was then a good 14-foot channel at this point, which was maintained to the end of the season.

The dredge left Andersons (359) November 17, and arrived at Montezuma Crossing (311) on the 18th, where she remained at the bank till November 21, when dredging was begun on this crossing. The work was completed on the 26th, when there was a 14-foot channel more than 250 feet in width, which was maintained the balance of the season.

The dredge was sent to Peters (272) and arrived there November 29, where she remained at the bank until December 5, when she was moved to Polks (266), as there were some signs of shoaling in this channel. Dredging was not required, how-

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ever, until December 22, when dredging was begun at 4.45 p. m., and continued without interruption until completion of the work at 10.15 a. m. December 26. There was a good 11-foot channel here.

The dredge departed for West Memphis at 1 p. m. December 31, and arrived at the fleet January 1, 1905, where she was laid up.

Dredge Henry Flad.—This dredge left the fleet August 19, and arrived at Last Chance Crossing (168) August 21, and after cleaning boilers commenced dredging on this crossing at 2.45 p. m. on the 22d, and completed the work at 5 p. m. August 27. The results were satisfactory, and at completion of the work there was a good 13-foot channel at this point.

The dredge departed August 29, and arrived at Reelfoot Crossing (100) September 1, after having lost twenty-four hours repairing feed-water heater. Dredging was begun at 7 p. m. September 1, and work was continued without serious delay, except that due to large drift, till September 3, when boilers were cleaned. Dredging was resumed at 5.40 a. m. on the 5th, and continued till 6 a. m. on the 8th, when the work contemplated was finished.

The work at this point was satisfactory. The dredge went to the foot of Island No. 16 (120) September 8. Dredging was begun at 8 a. m. September 11, and continued without serious interruptions till 4 a. m. of the 15th, when the work contemplated was completed. At this time there was a good 12½-foot channel over the crossing. The dredge then went to Fritz Landing (100), arriving September 16. Dredging was begun at 5 p. m. September 20, and was continued till the 24th, when boilers were cleaned and the result of a survey awaited. Dredging was resumed September 26, when twelve hours were lost on account of a hot crank pin, which finally required rebabbitting. This was completed and dredging resumed at 5 p. m. September 27, and continued till October 1, when work was discontinued on account of a rising river. Dredging was resumed on this crossing at 1 p. m. October 13. Work was continued till 5 p. m. of the 15th, when she went to the bank. At this time there was not less than 13 feet in the channel.

On October 19 the dredge went to Joe Eckles bar (92) to extend the cut made by the *Delta*, upstream. Dredging was commenced at 3.25 p. m. of the same day, and continued till the 21st, when work was completed. The channel previously made by the *Delta* at this point continued to improve, but had not been carried high enough upstream originally. This channel was maintained the balance of the season and there never was less than 11 feet over the crossing.

On completion of the work at Joe Eckles, the dredge was taken to the foot of Island No. 21 (133), and began dredging at 7.40 a. m. October 24 and continued till 8 a. m. of the 27th, when nine and one-half hours were lost by a hot crank pin on the main engine, necessitating rebabbitting. Dredging was resumed at 8.30 p. m. of the same day but the same trouble was experienced and ten hours were lost October 28. The work contemplated was finished on this day and the dredge started for Reelfoot, arriving there October 30. The result at foot of Island No. 21 was satisfactory and the channel remained good until about the middle of December.

The channel at Reelfoot Landing (100) was maintained, but steamboats experienced some difficulty in running it, and it was decided to dig another channel higher up. Dredging was begun at 7.30 a. m. November 1, and continued till 8.45 p. m. on the 3d, when the work was completed and the dredge went to the bank. The channel in this vicinity was maintained without dredging the balance of the season, and there was at no time less than 10 feet in the channel.

The dredge was moved to Caruthersville, for convenience, where she remained until December 13, when she departed for Last Chance Crossing (168). She reached Bullerton December 14, where she remained at the bank until 10.35 a. m. December 21, when dredging was begun. The reef was very short, and the work contemplated was completed at 9.40 p. m. December 22. The work at this point was very satisfactory and there was a 13-foot channel over the reef.

The dredge left Last Chance (168) at 9 a. m. December 23 and reached Island No. 21 (133) at 4 p. m. December 24. After delays caused by high wind and grounding of the dredge, dredging was begun at 8.40 a. m. of the 28th and finished at 3.30 a. m. of the 31st. She departed for West Memphis, Ark., January 1, 1905, where she arrived on the 2d, and was laid up.

SURVEYS.

Three survey parties were put in the field. One party covered that portion of the river between Nolans (76) and foot of Island No. 21 (133), the second from New Haven (162) to Presidents Island (233), and the third covered the river from Presidents Island to Andersons (359). One hundred and two surveys of troublesome bars were made during the season.

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INSPECTION.

The steamer *Search* was used during the season as an inspection boat, and the office of the superintendent was maintained on her during the season. The boat was continually patrolling the river with a double crew. All crossings were sounded, survey and dredging parties placed, and supplies were delivered to all the parties from Memphis. Twenty-five round trips were made. During the season there was not less than 9 feet in the channel at any point except Presidents Island.

A table (No. 10) is appended, showing channel depths as observed on the various trips.

The following tables are also submitted: Distribution of expenditures for the entire year (No. 9); distribution of time of dredges during the low-water season (No. 8).

Respectfully submitted.

WM. GERIG,
Assistant Engineer.

Capt. WM. B. LADUE,
Corps of Engineers, U. S. Army,
Secretary, Mississippi River Commission.

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TABLE No. 8.—*Summary of dredging operations, Mississippi River below Cairo, during the low-water season of 1904.*

DELTA.

Points of operation.	Distribution of time.									Distance towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth suction lowered.	Average depth of cut.	Average steam pressure per square inch.	Average speed main pump, revolutions per minute.
	Placing plant.	Dredging.	Changing cuts.	Repairing.	Passing boats.	Making up tow.	Towing.	Not working, awaiting lower stage, etc.	Total.								
	Hours.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Miles.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Pounds.*	
Lower Point Pleasant (82), Aug. 22 to Sept. 10	.....	172.20	7.55	[a] 85.50	.....	.....	12.20	193.35	472.00	82	9	6,800	39	17.3	6.2	160	135
Lower Point Pleasant, second time, Sept. 10 to 19	1.05	77.15	4.30	2.05	3.50	.....	.....	119.15	208.00	.....	7	6,560	85	16.3	5.0	156	131
Joe Eckles (93), Sept. 19 to 30	4.50	186.10	13.05	5.25	.....	3.00	2.00	54.20	268.50	11	15	14,110	76	18.2	6.6	151	132
Lower Point Pleasant (82), third time, Sept. 30 to Oct. 22	8.30	210.05	13.20	1.45	6.10	1.15	5.40	284.40	531.25	11	13	11,640	55	15.3	5.8	150	133
Lower Point Pleasant, upper crossing, Oct. 22 to 25	2.00	61.05	1.35	.....	.15	.....	.....	.....	64.55	.....	4	3,960	65	14.1	4.6	150	135
Lower Point Pleasant, lower crossing, Oct. 25 to 31	7.20	36.28	1.42	.....	.....	3.40	.25	109.15	158.50	.....	6	4,760	128	14.2	4.4	150	135
Lower Point Pleasant, lying up, Nov. 1 to Dec. 23	.....	.....	.....	.....	.....	.....	.....	1,255.25	1,255.25	.....	.....	.....	.....	.....	.....	.....	.....
Nolans (76), Dec. 23 to 31	6.40	65.19	9.41	4.25	.....	.....	5.00	105.20	196.25	6	8	6,880	105	13.6	3.6	151	132
Going into winter quarters (232), Dec. 31 to Jan. 2, 1905	.....	.....	.....	.....	.....	3.20	47.35	.....	50.55	156	.....	.....	.....	.....	.....	.....	.....
Total and average	30.25	808.42	51.48	99.30	10.15	11.15	73.00	2,121.50	3,206.45	266	62	54,710	68	16.0	5.5	152	133

EPSILON.

Presidents Island, lower (284), Sept. 2 to 8	6.28	105.06	9.50	16.56	.....	6.50	0.55	0.00	146.05	2	6	5,200	49	16.0	6.6	132	171
Corona (203), Sept. 8 to 19	4.35	138.00	20.55	.25	.....	8.05	24.00	68.55	264.55	31	14	10,200	74	16.0	5.4	131	174
Pecan Point (195), Sept. 19 to Oct. 12	10.10	64.55	14.15	.35	.....	2.15	6.40	461.40	560.30	8	11	8,850	136	16.0	4.4	132	173
Densfords or Walts (198), Oct. 12 to 23	4.15	193.15	30.55	.10	.....	5.35	1.10	32.10	267.30	3	23	19,075	99	16.0	5.6	134	173
Corona (203), second time, Oct. 23 to Nov. 30	4.55	139.05	35.05	69.05	.....	21.15	1.30	[b] 626.05	897.00	5	24	20,050	144	16.0	5.9	135	172
Pecan Point (195), second time, Nov. 30 to Dec. 8	7.30	84.15	14.30	3.15	.....	9.30	7.15	65.45	192.00	8	16	14,725	175	16.0	6.2	135	173

[a] Due in part to machinery running hot.

[b] Includes 22 hours cleaning boilers.

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TABLE No. 8.—*Summary of dredging operations, Mississippi River below Cairo, during the low-water season of 1904*—Continued.

EPSILON—Continued.

Points of operation.	Distribution of time.									Distance towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth suction lowered.	Average depth of cut.	Average steam pressure per square inch.	Average speed main pump, revolutions per minute.
	Placing plant.	Dredging.	Changing cuts.	Repairing.	Passing boats.	Making up tow.	Towing.	Not working, awaiting lower stage, etc.	Total.								
	Hours.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Miles.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Pounds.*	
Walts or Densfords (198), second time, Dec. 8 to 21	4.30	57.55	7.05	9.35	.....	4.35	2.30	[a] 225.50	312.00	3	10	7,850	136	15.3	6.2	140	175
Walts or Densfords (198), third time, Dec. 21 to Jan. 1	3.00	94.35	19.45	19.00	.....	6.40	1.30	[b] 119.30	264.00	.....	14	13,050	138	16.0	5.7	139	175
Going into winter quarters (232), Jan. 1, 1905	.....	.....	.....	.....	.....	.....	4.15	.....	4.15	34	.....	.....	.....	.....	.....	.....	.....
Total and average	45.23	877.06	152.20	119.01	.....	64.45	49.45	1,599.55	2,908.15	94	118	99,000	113	16.0	5.7	135	174

ZETA.

Corona (203), Aug. 27 to Sept. 8	6.00	101.25	11.10	.....	.....	4.30	22.30	142.15	287.50	29	11	11,000	108	16.7	3.9	138	175
Last Chance (168), Sept. 8 to 12	2.00	42.50	3.30	.....	.....	.50	20.20	24.35	94.05	35	8	4,325	101	18.0	4.3	140	175
Osceola (164), Sept. 12 to 20	8.00	67.35	5.45	2.30	.....	4.05	1.15	109.55	194.05	4	11	7,350	109	16.6	4.6	139	175
O'Donnells (149), Sept. 20 to Oct. 3	.....	.....	.....	.....	.....	3.30	8.00	300.55	312.25	15	.....	.....	.....	.....	.....	.....	.....
Presidents Island (233), Oct. 3 to 31	4.45	135.35	2.20	8.00	0.30	.....	17.20	520.05	688.35	84	6	4,825	36	14.0	4.5	140	175
Presidents Island (233), second time, Nov. 1 to 21	5.40	120.05	1.25	[c] 26.05	.....	.....	.30	340.10	493.55	.....	5	3,500	29	14.0	3.5	140	175
West Memphis, Nov. 21 to 30	.....	.....	.....	.....	.....	.....	2.35	223.30	226.05	1	.....	.....	.....	.....	.....	.....	.....
Total and average	21.25	467.30	24.10	36.35	.30	12.55	72.30	1,661.25	2,297.00	168	41	31,000	66	16.1	4.2	139	175

IOTA.

Presidents Island, lower (234), Sept. 8 to 23	25.30	87.00	18.30	[d] 54.20	.....	.....	2.45	[e] 189.20	372.25	2	11	8,650	99	16.0	7.1	144	164
Presidents Island, upper (233), Sept. 23 to Oct. 11	6.15	139.30	23.00	2.00	.....	.....	1.20	258.55	431.00	1	12	8,350	60	16.3	4.4	148	166
Peters Crossing (272), Oct. 11 to 26	2.05	88.50	2.35	.....	.....	.....	21.35	293.05	358.10	39	8	5,450	140	17.0	4.8	146	174
Montezuma (311), Oct. 26 to 31	2.00	42.30	3.00	.....	.....	1.05	22.00	48.15	118.50	39	8	7,100	167	17.0	5.2	143	170

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Polks (267), Oct. 31 to Nov. 11	2.30	80.35	5.50	.....	.....	3.25	92.50	128.50	264.00	45	11	7,900	258	17.0	4.6	132	166
Fleeces (243), Nov. 11 to 29	2.45	53.50	8.25	1.05	.....	.....	29.20	f 335.10	430.35	28	18	7,400	138	16.0	7.0	148	168
Fleeces (243), second time, Nov. 29 to Dec. 7	8.50	58.30	10.05	.....	.....	.....	.....	119.15	196.40	.....	15	10,350	177	16.0	5.5	141	167
Presidents Island, upper (233), second time, Dec. 7 to 29	24.10	207.40	27.20	81.20	45.30	.....	6.05	g 131.45	523.50	10	20	12,825	62	12.0	4.0	140	170
Moving into winter quarters, Dec. 29	.....	.....	.....	.....	.....	.....	1.15	.....	1.15	1	.....	.....	.....	.....	.....	.....	.....
Total and average	74.05	658.25	93.45	138.45	45.30	4.30	177.10	1,504.35	2,696.45	160	98	68,025	108	15.6	5.2	142	168

KAPPA.

Pecan Point (194), Aug. 19 to 26	1.45	89.45	6.00	.....	.....	.....	29.00	59.45	186.15	37	11	11,250	125	15.3	5.2	144	126
Pecan Point, lower (196), Aug. 26 to Sept. 7	14.00	126.00	6.30	.....	.....	.....	5.30	140.00	292.00	.....	19	15,800	125	16.6	5.4	142	128
Foot of Island 21 or Miss Hickmans (133), Sept. 7 to 15	1.30	72.15	7.45	1.45	1.00	12.00	49.00	h 28.30	173.45	62	10	8,350	116	16.0	6.1	140	129
Polks (267), Sept. 15 to Oct. 3	1.30	57.00	6.15	5.15	.....	9.15	19.15	344.00	442.30	134	11	9,250	162	16.5	3.6	142	129
Andersons (359), Oct. 3 to 20	1.00	95.45	13.45	1.45	.15	1.30	43.15	246.30	408.45	92	16	14,850	155	17.0	5.6	143	130
Andersons (359), second time, Oct. 20 to 31	2.00	45.00	8.00	2.30	.....	.....	2.00	218.15	277.45	.....	9	7,475	166	16.9	5.4	137	130
Andersons (359), third time, Nov. 1 to 17	1.15	38.30	11.15	.....	.....	.....	2.15	336.45	390.00	.....	9	6,975	181	18.0	4.3	139	130
Montezuma (311), Nov. 17 to 28	2.00	108.00	11.45	.45	.....	3.15	35.15	108.45	264.45	48	19	17,075	166	17.0	5.1	139	128
Peter's Crossing (272), Nov. 28 to Dec. 5	.....	.....	.....	.....	.....	.....	29.45	141.00	170.45	39	.....	.....	.....	.....	.....	.....	.....
Polks (267), Dec. 5 to 31	1.30	75.45	10.30	2.15	1.00	.....	5.00	531.30	627.30	6	15	13,550	179	15.0	4.9	136	130
Going into winter quarters, Dec. 31	.....	.....	.....	.....	.....	.....	11.00	.....	11.00	34	.....	.....	.....	.....	.....	.....	.....
Total and average	26.30	708.00	81.45	14.15	2.15	26.00	231.15	2,155.00	3,240.00	452	119	104,575	149	16.4	5.1	140	129

HENRY FLAD.

Last Chance (168), Aug. 18 to 28	2.15	112.50	6.55	2.35	.....	1.00	52.50	68.55	247.20	64	9	6,925	61	18.0	5.6	146	131
Reel Foot (100), Aug. 28 to Sept. 8	5.40	119.10	5.45	i 14.20	.....	1.10	53.55	47.10	247.10	68	9	6,625	56	17.3	6.0	149	130
Foot of Island 16 (120), Sept. 8 to 15	2.25	83.35	6.35	j 33.45	.....	6.35	3.35	k 29.45	166.15	20	11	9,075	109	16.0	6.2	149	129
Reel Foot (100), second time, Sept. 15 to Oct. 13	28.05	163.30	9.40	88.25	.....	8.25	33.45	392.25	674.15	20	14	10,925	67	17.8	6.8	145	128
Reel Foot (100), third time, Oct. 13 to 19	4.15	46.00	5.45	.....	.....	.....	2.30	k 85.00	143.30	.....	7	5,825	127	17.0	5.8	132	130

a Includes 192 hours lying up at Deans Island.
b Includes 26 hours 50 minutes cleaning boilers.
c Includes 23 hours 45 minutes repairing jet pump.
d Includes 38 hours 15 minutes repairing jet pump.
e Includes 21 hours 25 minutes cleaning boilers.
f Includes 12 hours 25 minutes waiting for coal.
g Includes 42 hours 55 minutes cleaning boilers.
h Cleaning boilers.
i Includes 11 hours 25 minutes repairing heater.
j Includes 31 hours 50 minutes repairing condenser.
k Includes 24 hours cleaning boilers.

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TABLE No. 8.—*Summary of dredging operations, Mississippi River below Cairo, during the low-water season of 1904*—Continued.

HENRY FLAD—Continued.

Points of operation.	Distribution of time.									Distance towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth suction lowered.	Average depth of cut.	Average steam pressure per square inch.	Average speed main pump, revolutions per minute.
	Placing plant.	Dredging.	Changing cuts.	Repairing.	Passing boats.	Making up tow.	Towing.	Not working, awaiting lower stage, etc.	Total.								
	Hours.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Miles.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Pounds.*	
Joe Eckles (93), Oct. 19 to 21	4.10	32.45	2.20	.....	1.30	1.40	3.35	.....	46.00	7	5	4,250	130	16.0	5.8	128	123
Island 21 (133), Oct. 21 to 28	1.20	74.35	8.00	a 19.35	.....	3.55	25.25	51.00	183.50	40	11	8,050	108	16.0	5.7	127	126
Reel Foot (100), fourth time, Oct. 28 to Nov. 9	5.05	44.10	5.05	.....	.....	3.10	38.00	178.15	273.45	33	12	5,000	113	15.9	4.5	131	129
Caruthersville (110), Nov. 9 to Dec. 13	.....	.....	.....	.....	.....	1.00	2.00	814.10	817.10	10	.....	.....	.....	.....	.....	.....	.....
Last Chance or Bullerton (168), Dec. 13 to 23	4.35	31.35	2.55	.....	.35	.....	25.45	173.50	239.15	58	7	5,000	158	15.0	4.4	132	138
Island 21 (133), second time, Dec. 23 to 31	13.00	40.55	2.50	22.50	.35	3.00	32.00	94.50	210.00	35	6	4,800	117	16.1	4.9	135	133
Going into winter quarters, Jan. 1 to 2, 1905	.....	.....	.....	.....	.....	1.00	26.30	.....	27.30	99	.....	.....	.....	.....	.....	.....	.....
Total and average	70.50	749.05	55.50	131.30	2.40	30.55	299.50	1,935.20	3,276.00	454	91	66,475	89	16.7	5.7	141	129

a Mainly on account of main engine crank pin running hot.

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TABLE No. 9.—*Cost of dredging operations, April 1, 1904, to April 30, 1905.*

	Labor.	Office supplies.	Subsistence.	Fuel.	Lighting supplies.	Lubricants.	Repairs.	New plant.	Total.	Grand total.
Care of plant	$39,426.97	$183.55	$7,271.77	$10,116.27	$178.39	$207.79	$421.03	.....	.....	$57,805.77
Repairs to plant:										
Dredge Beta	1,085.73	.28	188.96	.....	.34	7.51	611.51	.....	$1,894.33	.....
Dredge Gamma	2,233.61	.....	419.81	274.70	39.66	68.31	791.08	.....	3,827.17	.....
Dredge Delta	3,304.66	.....	738.14	912.07	19.48	78.54	1,447.01	.....	6,494.90	.....
Dredge Epsilon	2,799.36	.35	578.47	71.95	8.37	31.36	928.11	.....	4,418.47	.....
Dredge Zeta	2,108.79	.....	516.62	2.00	.89	13.13	940.26	.....	3,581.69	.....
Dredge Iota	2,513.77	.....	515.24	35.55	4.37	27.90	983.80	.....	4,080.63	.....
Dredge Kappa	2,819.28	.....	546.22	117.13	1.61	41.76	736.17	.....	4,262.17	.....
Dredge Henry Flad	2,964.61	.....	644.18	45.89	6.24	84.77	907.40	.....	4,653.09	.....
Steamer Sachem	1,289.77	.....	258.73	47.25	1.84	28.00	449.83	.....	2,075.42	.....
Steamer Choctaw	1,686.29	.....	326.08	.....	4.34	22.29	603.68	.....	2,642.63	.....
Steamer Nokomis	1,898.15	.26	408.31	.....	7.98	59.22	602.93	.....	2,971.85	.....
Steamer Wynoka	2,172.62	.79	448.03	212.45	6.74	57.61	410.47	.....	3,308.71	.....
Steamer Leota	1,615.71	.....	308.31	.....	4.19	19.18	514.66	.....	2,462.05	.....
Steamer Minnetonka	2,981.04	.....	361.78	766.96	4.31	120.08	17,674.46	.....	21,908.63	.....
Steamer Search	1,452.53	.....	249.20	.....	1.96	16.73	760.82	.....	2,481.24	.....
Steamer Vulcan	763.59	.....	135.32	.....	.59	1.21	128.62	.....	1,029.33	.....
Steamer Venus	680.95	.....	118.46	.....	2.14	16.20	186.59	.....	1,004.34	.....
Steamer Mars	69.08	.....	12.70	.....	.....	2.68	9.95	.....	94.41	.....
Steamer Mercury	478.85	.....	94.04	.....	.36	2.98	138.40	.....	714.63	.....
Pile sinker No. 61	.....	.....	.....	.....	.....	.....	19.67	.....	19.67	.....
Pile sinker No. 971	74.98	.....	11.14	.....	.....	.....	26.57	.....	112.64	.....
Pile sinker No. 981	319.04	.....	48.96	.....	.....	.63	55.30	.....	423.93	.....
Pile sinker No. 982	347.08	.....	57.46	.....	.....	7.02	78.69	.....	490.25	.....
Pile sinker No. 983	91.78	.....	15.75	.....	.....	2.83	31.97	.....	142.33	.....
Pile sinker No. 984	381.56	.....	63.99	.....	.....	4.29	71.38	.....	521.22	.....
Barge No. 041	7.24	.....	1.44	.....	.....	.....	.....	.....	8.68	.....
Sectional docks	16.01	.....	2.31	.....	.....	1.40	12.61	.....	32.33	.....
Skiffs	255.67	.....	49.21	.....	.....	.....	83.44	.....	388.32	.....
Calking flat	43.67	.....	9.10	.....	.....	.....	.....	.....	52.77	.....
Tools and appliances	1,291.32	.....	188.40	12.00	.09	7.96	208.60	.....	1,708.37	.....
Total	37,746.69	1.68	7,311.81	2,497.95	115.50	719.09	29,413.98	.....	77,806.20	77,806.20
Operations during low-water season, 1904:										
Dredge Beta	4,506.[illegible]	5.00	907.60	932.23	31.80	178.40	101.75	.....	6,663.73	.....
Dredge Delta	12,550[illegible]	9.76	3,053.57	8,472.98	67.58	426.55	728.88	.....	25,309.51	.....
Dredge Epsilon	11,397.[illegible]	15.62	2,502.93	9,635.04	93.12	372.85	597.91	.....	24,615.07	.....
Dredge Zeta	8,890.29	7.70	1,810.78	5,402.38	26.70	159.34	211.92	.....	16,509.11	.....
Dredge Iota	8,910.24	8.07	2,118.29	8,564.85	41.05	245.47	273.25	.....	20,161.22	.....
Dredge Kappa	10,188.16	9.80	2,138.27	7,351.83	52.72	170.38	237.48	.....	20,148.14	.....
Dredge Henry Flad	9,621.34	9.97	2,257.04	7,555.40	51.34	214.56	197.74	.....	19,907.39	.....

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TABLE No. 9.—*Cost of dredging operations, April 1, 1904, to April 30, 1905*—Continued.

	Labor.	Office supplies.	Subsistence.	Fuel.	Lighting supplies.	Lubricants.	Repairs.	New plant.	Total.	Grand total.
Operations during low-water season, 1904—Continued.										
Steamer Search	$6,673.43	$35.60	$1,237.25	$2,764.35	$16.56	$85.61	$40.34	.....	$10,853.14	.....
Steamer Vulcan	1,985.26	37.40	478.06	379.15	19.08	15.08	24.22	.....	2,938.25	.....
Steamer Venus	1,972.68	35.65	419.92	515.45	13.85	11.81	12.05	.....	2,981.41	.....
Steamer Mercury	2,441.68	49.02	600.13	617.04	14.28	23.85	7.29	.....	3,753.29	.....
Total	79,137.82	223.09	17,523.84	52,190.70	428.08	1,903.90	2,432.83	.....	153,840.26	$153,840.26
New plant:										
Grounds and buildings	1,628.71	.....	273.86	.....	.09	3.21	1,191.08	.....	3,096.95	.....
Barges	1,504.23	.....	242.56	8.00	.....	8.55	987.41	.....	2,750.75	.....
Sectional docks	2,134.04	.....	344.02	9.00	.09	12.75	1,516.25	.....	4,016.15	.....
Tools, appliances, and outfit	.....	.....	.....	.....	.....	.....	.....	$12,672.48	12,672.48	.....
Total	5,266.98	.....	860.44	17.00	.18	24.51	3,694.74	12,672.48	22,536.33	22,536.33

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TABLE No. 10.—*Depths over shoal crossings, Mississippi River below Cairo, low-water season of 1904.*

[R indicates river rising.]

Name of bar.	Miles below Cairo.	Dates of trips, 1904.													
		Aug. 14 to 15.	Aug. 17 to 21.	Aug. 22 to 23.	Aug. 26.	Aug. 30 to 31.	Sept. 1.	Sept. 5 to 6.	Sept. 8 to 9.	Sept. 10 to 11.	Sept. 14 to 16.	Sept. 18 to 20.	Sept. 21 to 22.	Sept. 24 to 26.	Sept. 26 to 27.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Cairo gauge	0	11.0	10.8	.....	.....	.....	11.4	9.2 to 9.0	9.3 to 8.8	8.8 to 8.1	8.0 to 7.8	7.0 to 9.4	10.4 to 11.4	12.1 to 11.2	11.3 to 10.8
New Madrid gauge	70	9.2 to 9.1	9.2 to 9.4	.....	.....	.....	9.6	7.8	7.6 to 7.5	7.4 to 7.1	6.8	6.5 to 6.8	7.7 to 8.9	9.6 to 9.2	9.3 to 8.9
New Madrid	71	15.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nolans	76	.....	9.5	.....	.....	.....	11.5	.....	.....	.....	.....	.....	.....	.....	.....
Tonys Crossing	.....	10.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lower Point Pleasant	82	9.0	9.0	9.0	.....	9.0	.....	11.0	.....	13.0	10.5	10.5	.....	.....	.....
Linda Landing	83	.....	.....	.....	.....	.....	.....	.....	.....	9.5	.....	.....	.....	.....	.....
Gurvins	84	.....	18.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cherokee	90	14.0	11.0	15.0	.....	.....	.....	13.0	.....	.....	.....	.....	.....	.....	.....
Joe Eckles	93	10.5	11.0	15.0	.....	.....	.....	12.0	.....	10.0	9.0	9.0	.....	12.0	.....
Burnleys	100	.....	11.0	11.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Above Reelfoot	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Reelfoot	100	.....	.....	.....	.....	.....	.....	11.0	.....	11.5	9.5	.....	.....	11.0	.....
Opposite Reelfoot	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Frits	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.0	.....	14.0	.....
Hathaway	103	16.0	.....	18.0	.....	.....	.....	15.0	.....	.....	14.0	.....	.....	.....	.....
Foot of Island No. 16	120	10.0	11.0	14.0	.....	.....	.....	11.0	.....	9.0	12.0	12.5	.....	13.0	.....
Cottonwood Point gauge	123	6.75	6.5 to 6.25	7.0	.....	.....	7.3	5.4 to 4.9	4.9 to 4.9	4.8 to 4.5	4.2 to 4.0	3.8 to 3.6	4.1 to 5.6	6.4 to 6.5	6.8 to 6.4
Head of Island No. 20	127	15.0	.....	.....	.....	.....	.....	15.0	.....	.....	.....	.....	.....	.....	.....
Foot of Island No. 20	128	.....	14.0	.....	.....	.....	.....	14.0	.....	.....	.....	12.0	.....	.....	.....
Head of Island No. 21	128	9.5	15.0	.....	.....	.....	.....	14.0	.....	.....	.....	.....	.....	.....	.....
Foot of Island No. 21	133	.....	.....	.....	.....	11.5	.....	10.0	.....	9.0	13.0	12.0	.....	16.0	.....
Brolaski	133	11.5	11.0	11.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Forked Deer	146	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mouth Forked Deer River	147	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
O'Donnells	148	16.0	.....	.....	.....	.....	.....	.....	.....	13.0	.....	9.5	.....	.....	.....
Gold Dust	159	15.0	14.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Haven—Outside	162	.....	.....	.....	.....	12.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Haven	163	13.0	14.0	.....	.....	.....	13.0	13.0	11.0	9.5	10.5	11.0	.....	.....	.....
Below New Haven	163	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Last Chance or Bullerton	168	9.5	9.5	.....	.....	13.0	13.0	11.0	11.5	13.0	11.5	10.5	.....	.....	.....

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TABLE No. 10.—*Depths over shoal crossings, Mississippi River below Cairo, low-water season of 1904*—Continued.

Name of bar.	Miles below Cairo.	Dates of trips, 1904. Aug. 14 to 15.	Aug. 17 to 21.	Aug. 22 to 23.	Aug. 26.	Aug. 30 to 31.	Sept. 1.	Sept. 5 to 6.	Sept. 8 to 9.	Sept. 10 to 11.	Sept. 14 to 16.	Sept. 18 to 20.	Sept. 21 to 22.	Sept. 24 to 26.	Sept. 26 to 27.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Fulton gauge	175	7.75	.....	7.5 to 7.8	.....	9.0 to 8.8	8.4	6.6 to 6.3	6.0 to 6.1	6.1 to 5.8	5.4 to 5.2	5.1 to 4.8	4.9 to 6.1	7.2 to 7.8	7.9 to 7.5
Random Shot	192	.....	9.0	9.0	.....	11.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pecan Point	195	.....	.....	.....	.....	.....	10.5	10.5	9.0	9.0	9.0	9.0	.....	14.0	.....
Walts or Densfords	198	.....	.....	11.0	.....	13.0	.....	.....	.....	10.5	10.5	9.0	.....	.....	.....
Corona	203	.....	9.5	9.0	.....	10.5	10.5	10.0	11.0	.....	12.0	11.0	.....	12.5	.....
Foot of Island No. 40	221	.....	13.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Chickasaw Bluffs	222	.....	14.0	.....	.....	.....	.....	15.5	.....	.....	.....	.....	.....	.....	.....
Memphis gauge	230	.....	6.25	6.5R	7.6R	7.9 to 7.8	7.6	5.8 to 5.4	5.0 to 4.8	4.8	4.4 to 4.2	4.0 to 3.9	3.8 to 4.3	5.7 to 6.8	6.8 to 6.6
Presidents Island	234	.....	.....	.....	13.0	.....	.....	9.5	.....	9.5	9.0	.....	8.5	9.0	12.0
Fleeces	243	.....	.....	.....	15.0	.....	.....	.....	.....	9.5	11.0	.....	11.0	.....	15.5
Graves Bayou	250	16.0	.....	.....	13.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cow Island	251	.....	.....	.....	.....	.....	.....	.....	.....	14.0	13.0	.....	.....	.....	16.0
Norfolk	255	18.0	.....	.....	.....	.....	.....	.....	.....	13.5	13.5	.....	13.0	.....	.....
Star Crossing	260	15.0	.....	.....	.....	.....	.....	.....	.....	.....	13.5	.....	13.0	.....	15.5
Polks	267	11.0	.....	.....	13.5	.....	.....	.....	.....	11.0	9.5	.....	10.0	.....	.....
Blues Point	270	15.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13.5	.....	.....
Peters	272	10.0	.....	.....	13.5	.....	.....	.....	.....	12.0	9.5	.....	11.5	.....	12.5
Ashley Point	274	12.5	.....	.....	14.0	.....	.....	.....	.....	11.5	11.0	.....	11.5	.....	12.0
Mhoons	276	.....	.....	.....	.....	.....	.....	.....	.....	.....	13.0	.....	13.0	.....	.....
Hardins Point	286	.....	.....	.....	.....	.....	.....	.....	.....	.....	16.0	.....	.....	.....	.....
Helena gauge	306	.....	.....	.....	11.0R	.....	11.8	9.7 to 9.0	8.4 to 8.2	8.1	7.6 to 7.2	7.0 to 6.8	6.7	8.0 to 9.8	9.6 to 10.0
Montezuma	311	.....	.....	.....	16.0	.....	.....	.....	.....	.....	.....	.....	12.0	.....	13.0
Towhead of Island No. 62	312	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Island No. 63	332	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Island No. 66	352	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16.0	.....	12.5
Sunflower Landing gauge	353	.....	.....	.....	.....	.....	12.9	11.2 to 10.4	9.7 to 9.4	9.4 to 9.3	8.8 to 8.3	8.2 to 8.0	7.9 to 7.7	8.6 to 10.8	10.5 to 11.4
Andersons	359	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.0
Parkers	376	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.5
Mouth White River gauge	393	.....	.....	.....	.....	.....	17.4	14.9 to 13.8	12.8 to 12.3	12.1 to 11.9	11.4 to 10.8	10.5 to 10.3	10.2 to 10.0	10.5 to 12.7	12.4 to 13.4

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Name of bar.	Miles below Cairo.	Dates of trips, 1904.													
		Sept. 28.	Oct. 1 to 2.	Oct. 7 to 8.	Oct. 11 to 12.	Oct. 14 to 15.	Oct. 18 to 19.	Oct. 20 to 22.	Oct. 23.	Oct. 25 to 26.	Oct. 27 to 28.	Nov. 1 to 2.	Nov. 4 to 5.	Nov. 7 to 8.	Nov. 16 to 18.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Cairo gauge	0	11.2	12.2 to 12.8	11.4 to 10.4	9.0 to 8.5	8.0 to 7.7	7.1 to 7.0	7.0 to 6.8	6.8	6.9 to 7.0	7.1 to 7.4	8.8 to 9.3	9.4	9.2 to 9.0	8.6 to 8.2
New Madrid gauge	70	8.9	9.6 to 9.9	9.5 to 8.7	7.6 to 7.2	6.7 to 6.4	5.9 to 5.8	5.7 to 5.5	5.5	5.5 to 5.6	5.7 to 6.0	6.8 to 7.2	7.5	7.3 to 7.2	6.7 to 6.4
New Madrid	71														
Nolans	76									10.5					
Tonys Crossing															
Lower Point Pleasant	82		13.0		11.0		10.0			14.0		13.5		14.0	12.5
Linda Landing	83						9.0			9.0				13.0	
Gurvins	84						11.0			10.0				16.0	
Cherokee	90														
Joe Eckles	93		14.0		12.0		10.5			12.0		14.0		14.0	13.5
Burnleys	100														
Above Reelfoot	100														
Reelfoot	100													14.5	13.0
Opposite Reelfoot	100		13.5		11.0		11.0			10.0					
Fritz	100		14.0		13.0		11.0					13.0		14.5	
Hathaway	103						13.0								
Foot of Island No. 16	120		17.0		14.0		10.5			12.0		13.0		15.0	15.0
Cottonwood Point gauge	123	6.2	6.7 to 7.0	6.9 to 6.3	5.0 to 4.5	4.0 to 3.7	3.1 to 2.9	2.8 to 2.6	2.6	2.5 to 2.8	2.8 to 3.0	3.8 to 4.1	4.5 to 4.6	4.5 to 4.4	3.8 to 3.6
Head of Island No. 20	127		14.0												
Foot of Island No. 20	128														
Head of Island No. 21	128				12.0		11.0					11.0		14.5	
Foot of Island No. 21	133		15.5		13.5		10.5			9.5		10.0		12.0	12.0
Brolaski	133														
Forked Deer	146														
Mouth Forked Deer River	147									13.0					
O'Donnells	149									13.0					

Indian Point	406														13.5
Cypress Bend	425														14.0
Choctaw	435														14.5
Arkansas City gauge	438						15.4	13.1 to 11.8	10.7 to 10.0	9.8 to 9.5	9.0 to 8.2	7.9 to 7.7	7.6 to 7.6	7.6 to 9.8	9.4 to 10.7
Head of Island No. 82	455														14.0
Salona	475														14.0
Greenville gauge	478														

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TABLE No. 10.—*Depths over shoal crossings, Mississippi River below Cairo, low-water season of 1904*—Continued.

Name of bar.	Miles below Cairo.	Dates of trips, 1904.												
		Sept. 28.	Oct. 1 to 2.	Oct. 7 to 8.	Oct. 11 to 12.	Oct. 14 to 15.	Oct. 18 to 19.	Oct. 20 to 22.	Oct. 23.	Oct. 25 to 26.	Oct. 27 to 28.	Nov. 1 to 2.	Nov. 4 to 5.	Nov. 7 to 8.	Nov. 16 to 18.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Gold Dust	159	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Haven—Outside	162	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Haven	163	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11.5
Below New Haven	163	.....	14.0	.....	11.5	.....	11.5	.....	.....	11.0	.....	11.0	.....	.....	.....
Last Chance or Bullerton	168	.....	12.0	.....	13.0	.....	12.0	.....	.....	11.0	.....	11.5	.....	12.5	11.5
Fulton gauge	175	7.2	7.5 to 7.8	7.8 to 7.5	6.3 to 5.8	5.3 to 5.0	4.4 to 4.2	4.0 to 3.9	3.9	3.8 to 3.8	3.8 to 3.9	4.6 to 4.9	5.4 to 5.5	5.5 to 5.4	4.7 to 4.6
Random Shot	192	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pecan Point	196	.....	14.0	.....	14.0	.....	13.0	.....	.....	12.5	.....	12.5	.....	13.0	14.0
Walts or Densfords	198	.....	.....	.....	10.5	.....	10.0	.....	.....	10.5	.....	11.5	.....	12.0	11.5
Corona	203	.....	13.0	.....	10.5	.....	10.0	.....	.....	9.5	.....	13.0	.....	11.0	13.0
Foot of Island No. 40	221	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Chickasaw Bluffs	222	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Memphis gauge	230	6.4	6.1 to 6.5	6.9 to 6.5	5.5 to 5.0	4.4 to 4.1	3.6 to 3.4	3.2 to 3.0	3.0	3.0 to 3.0	3.0 to 3.0	3.6 to 4.0	4.5 to 4.8	5.0	4.4 to 4.3
Presidents Island	234	.....	11.5	13.0	.....	9.5	.....	9.5	.....	.....	8.5	.....	10.0	.....	9.0
Fleeces	243	.....	.....	15.0	.....	12.5	.....	9.5	10.5	.....	11.0	.....	13.0	.....	.....
Graves Bayou	250	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cow Island	251	.....	.....	16.0	.....	13.5	.....	.....	12.5	.....	.....	.....	.....	.....	.....
Norfolk	255	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Star Crossing	260	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Polks	267	.....	.....	14.0	.....	12.0	.....	9.5	11.5	.....	11.5	.....	11.0	.....	.....
Blues Point	270	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Peters	272	.....	.....	13.5	.....	11.0	.....	12.0	13.0	.....	12.0	.....	13.5	.....	.....
Ashley Point	274	.....	.....	14.5	.....	14.0	.....	11.5	12.5	.....	13.0	.....	.....	.....	.....
Mhoons	276	.....	.....	.....	.....	15.0	.....	.....	12.0	.....	.....	.....	.....	.....	.....
Hardins Point	286	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Helena gauge	306	10.0	9.3 to 9.6	10.5 to 10.2	9.2 to 8.4	7.6 to 7.3	6.5 to 6.2	6.2 to 5.6	5.6	5.4 to 5.4	5.4 to 5.3	5.8 to 6.0	6.5 to 6.8	7.0 to 7.1	6.3
Montezuma	311	.....	.....	.....	.....	12.0	.....	.....	11.0	.....	10.0	.....	14.0	.....	.....
Towhead of Island No. 62	312	.....	.....	.....	.....	.....	.....	.....	13.5	.....	.....	.....	.....	.....	.....
Island No. 63	332	.....	.....	12.0	.....	16.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
Island No. 66	352	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sunflower Landing gauge	353	11.5	10.8 to 10.8	11.8 to 11.7	10.8 to 10.1	9.1 to 8.5	7.8 to 7.3	7.2 to 6.7	6.6	6.4 to 6.3	6.3 to 6.3	6.6 to 7.0	7.5 to 7.9	8.3 to 8.4	7.2

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Andersons	359			12.0		11.0		11.5	13.0		12.0		12.0		
Parkers	376	16.0						12.5					12.0		
Mouth White River gauge	393	13.8	13.0 to 13.0	14.1 to 14.1	14.8 to 13.8	12.0 to 11.2	10.0 to 9.7	9.5 to 9.0	8.8	8.5 to 8.5	8.4 to 8.3	8.5 to 8.8	9.2 to 9.6	10.0 to 10.1	9.4 to 9.1
Indian Point	406	17.0						11.0					11.5		
Cypress Bend	425	16.5						13.0							
Choctaw	435	17.0						11.5							
Arkansas City gauge	438	11.2	10.8 to 10.5	11.7 to 11.8	12.3 to 12.3	10.6 to 9.4	7.8 to 7.4	7.1 to 6.6	6.4	6.0 to 5.9	5.9 to 5.8				
Head of Island No. 82	455	16.0						11.5							
Salona	475							14.5							
Greenville gauge	478		8.8 to 8.5	9.3 to 9.4	9.6 to 9.9	8.9 to 7.8	6.6 to 6.2	6.0 to 5.5	5.3	5.0 to 4.9	4.8 to 4.8				

Name of bar.	Miles below Cairo.	Dates of trips, 1904. Nov. 19 to 20.	Nov. 23 to 24.	Nov. 26 to 27.	Nov. 28 to 30.	Dec. 3 to 4.	Dec. 7 to 8.	Dec. 10.	Dec. 11 to 14.	Dec. 14 to 15.	Dec. 17 to 18.	Dec. 21 to 22.	Dec. 22 to 23.	Dec. 26 to 27.	Dec. 29 to 30.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Cairo gauge	0	8.1 to 7.9	7.3 to 7.0	6.7 to 6.5	6.4 to 6.0	5.7 to 5.6	5.5 to 5.4	5.4	5.8 to 6.7	6.7 to 6.6	5.9 to 5.2	3.7 to 3.5	3.5 to 3.3	3.1 to 3.7	9.0 to 12.6
New Madrid gauge	70	6.4 to 6.2	5.8 to 5.5	5.2 to 5.1	5.0 to 4.7	4.4 to 4.3	4.1	4.0	4.2 to 4.9	4.9 to 5.0	4.6 to 4.1	3.0 to 2.7	2.7 to 2.5	2.3 to 2.6	4.6 to 8.1
New Madrid	71														
Nolans	76											9.0			10.5
Tonys Crossing															
Lower Point Pleasant	82		12.0		11.5		11.0		11.0			11.0			14.0
Linda Landing	83		13.0		11.0		11.0		12.0			11.0			15.0
Gurvins	84		14.0		12.0		12.0		10.0	12.0		10.5			11.5
Cherokee	90				11.0		10.0		11.0	11.0		11.0			11.5
Joe Eckles	93		13.5		11.5		11.0		11.0	11.5					13.0
Burnleys	100														
Above Reelfoot	100						10.0			11.0		11.5			12.0
Reelfoot	100		16.0		15.5		13.5		10.0	14.0		13.0			14.0
Opposite Reelfoot	100								13.0						
Fritz	100		13.0		11.0		10.0		10.0	11.5		10.0			11.0
Hathaway	103		12.0		13.0		11.5		12.0	13.0		12.0			13.0
Foot of Island No. 16	120		13.5		14.0		13.5		13.0	14.0		13.0			13.0
Cottonwood Point gauge	123	3.5 to 3.3	2.9 to 2.7	2.4 to 2.2	2.0 to 1.8	1.4 to 1.3	1.1 to 1.0	1.0	1.0 to 1.6	1.6 to 1.8	1.7 to 1.2	0.2 to —0.2	—0.2 to —0.6	—0.7	0.0 to 3.1
Head of Island No. 20	127				12.0		11.0		10.0	11.0			9.0		9.5
Foot of Island No. 20	128				14.5		13.5		13.0	13.0			12.0		14.0

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TABLE No. 10.—*Depths over shoal crossings, Mississippi River below Cairo, low-water season 1904*—Continued.

Name of bar.	Miles below Cairo.	Date of trips, 1904.													
		Nov. 19 to 20.	Nov. 23 to 24.	Nov. 26 to 27.	Nov. 28 to 30.	Dec. 3 to 4.	Dec. 7 to 8.	Dec. 10.	Dec. 11 to 14.	Dec. 14 to 15.	Dec. 17 to 18.	Dec. 21 to 22.	Dec. 22 to 23.	Dec. 26 to 27.	Dec. 29 to 30.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Head of Island No. 21	128	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Foot of Island No. 21	133	.....	12.0	.....	12.0	.....	10.0	.....	9.0	.....	.....	.....	9.0	.....	11.0
Brolaski	133	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Forked Deer	146	.....	.....	.....	.....	.....	.....	.....	.....	12.0	.....	.....	11.0	.....	.....
Mouth Forked Deer River	147	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
O'Donnells	149	.....	.....	.....	13.0	.....	.....	.....	.....	.....	.....	.....	14.0	.....	.....
Gold Dust	159	.....	.....	.....	.....	.....	.....	.....	.....	13.0	.....	.....	11.0	.....	.....
New Haven—outside	162	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Haven	163	.....	11.5	.....	11.0	.....	10.0	.....	10.0	11.0	.....	.....	11.0	.....	12.0
Below New Haven	163	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Last Chance or Bullerton	168	.....	11.5	.....	10.5	.....	10.0	.....	10.0	11.0	.....	.....	11.0	.....	13.0
Fulton gauge	175	4.5 to 4.4	4.0 to 3.8	3.5 to 3.2	3.2 to 2.8	2.5 to 2.4	2.2 to 2.0	2.0	2.0 to 2.5	2.5 to 2.7	2.8 to 2.5	1.4 to 1.0	1.0 to .6	.3 to .4	.8 to 2.9
Random Shot	192	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pecan Point	195	.....	10.0	.....	11.0	.....	12.0	.....	10.0	11.5	.....	.....	10.5	.....	11.0
Walts or Densfords	198	.....	11.5	.....	10.0	.....	10.0	.....	10.0	9.5	.....	.....	10.0	.....	11.0
Corona	203	.....	12.5	.....	12.0	.....	11.5	.....	11.5	12.0	.....	.....	10.0	.....	11.0
Foot of Island No. 40	221	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Chickasaw Bluffs	222	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Memphis gauge	230	4.2 to 4.0	3.6 to 3.3	3.0 to 2.9	2.8 to 2.4	2.2 to 2.0	1.9 to 1.8	1.8	1.8 to 2.0	2.0 to 2.3	2.4	1.6 to 1.3	1.3 to .9	.6 to 1.6	2.2 to 2.6
Presidents Island	234	10.0	.....	9.5	8.5	8.5	.....	8.0	.....	9.0	10.0	.....	9.0	8.5	9.0
Fleeces	243	10.5	.....	9.0	9.0	11.0	.....	9.0	.....	.....	10.5	.....	.....	10.0	.....
Graves Bayou	250	.....	.....	.....	.....	.....	.....	11.5	.....	.....	.....	.....	.....	11.0	.....
Cow Island	251	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Norfolk	255	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.5	.....
Star Crossing	260	.....	.....	.....	.....	.....	.....	11.0	.....	.....	.....	.....	.....	10.5	.....
Polks	267	13.0	.....	12.0	.....	11.0	.....	10.0	.....	.....	11.0	.....	.....	11.0	.....
Blues Point	270	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Peters	272	13.0	.....	11.5	.....	12.0	.....	10.0	.....	.....	11.5	.....	.....	10.0	.....
Ashley Point	274	.....	.....	.....	.....	.....	.....	11.0	.....	.....	.....	.....	.....	.....	.....
Mhoons	276	.....	.....	13.5	.....	.....	.....	.....	.....	.....	12.0	.....	.....	12.0	.....
Hardins Point	286	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Helena gauge	306	6.2 to 6.1	5.8 to 5.5	5.2 to 5.0	4.9 to 4.5	4.2 to 4.0	3.8 to 3.6	3.5	3.4	3.4 to 3.7	4.0 to 4.1	3.5 to 3.1	3.1 to 2.6	2.3 to 3.8	3.8 to 4.3

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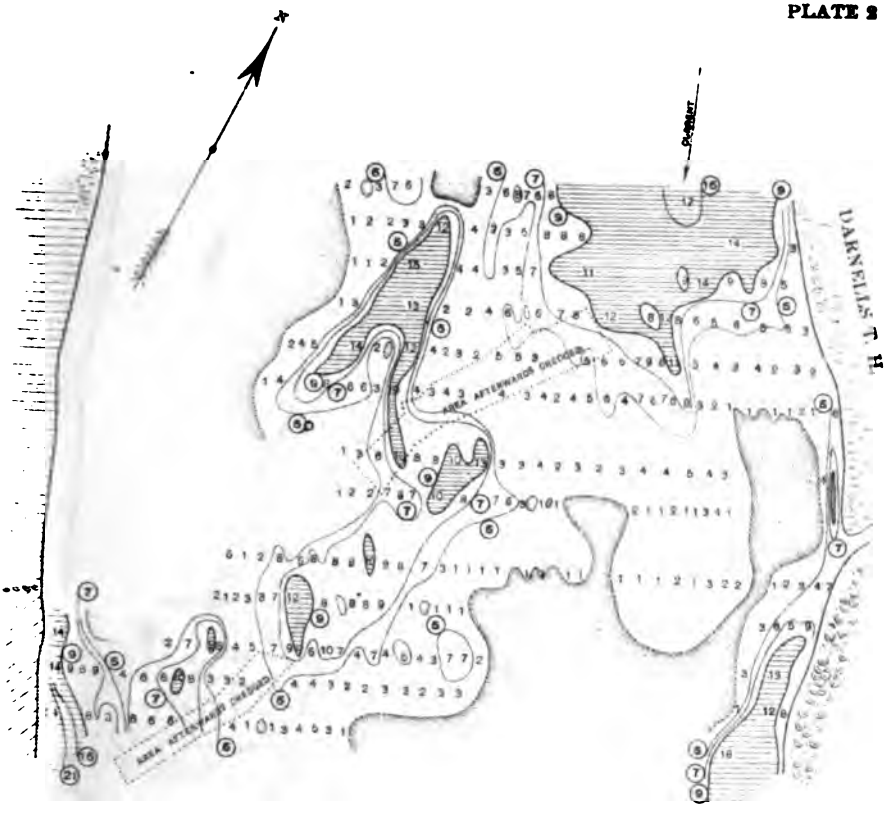

MISSISSIPPI RIVER COMMISSION.

MAP OF

LOWER POINT PLEASANT CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of August 20, 1904,

SIX DAYS BEFORE DREDGING BY DREDGE DELTA—FIRST TIME.

SCALE OF FEET.

1000 500 000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid, M. R. C. gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 9.4 feet or 6.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

JUDGE & DUNLAP CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

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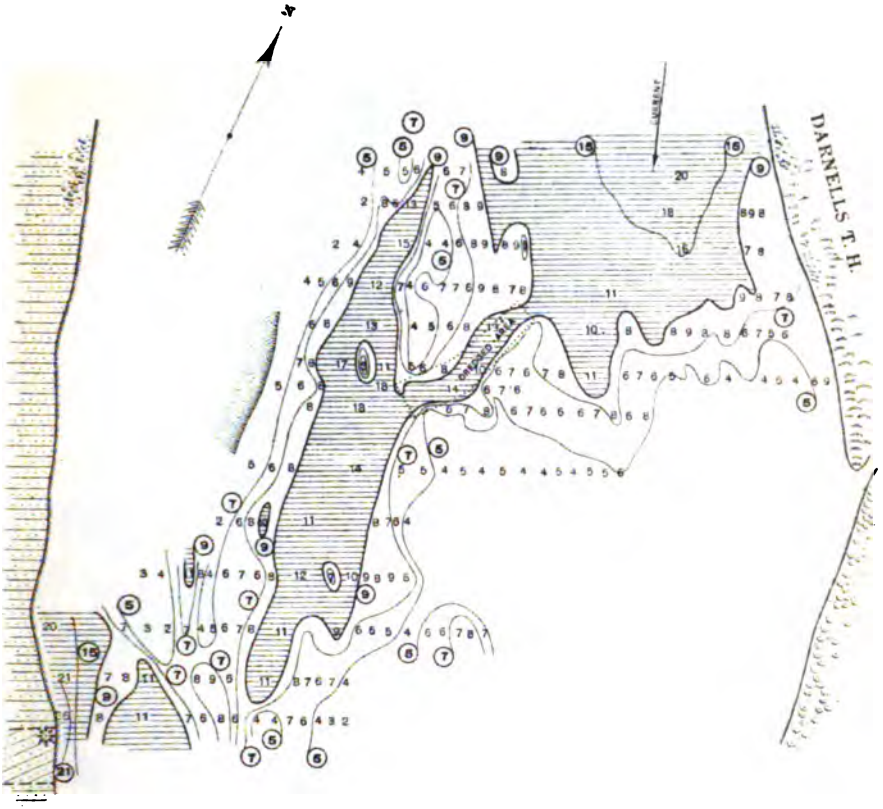

MISSISSIPPI RIVER COMMISSION.

MAP OF

LOWER POINT PLEASANT CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 7, 1904,

ONE DAY AFTER DREDGING BY DREDGE *DELTA*—FIRST TIME.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid, M. R. C. gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 7.4 feet or 4.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

JUDSON & GRAHAM CO. PHOTO-LITHOGRAPHERS. WASHINGTON D. C.

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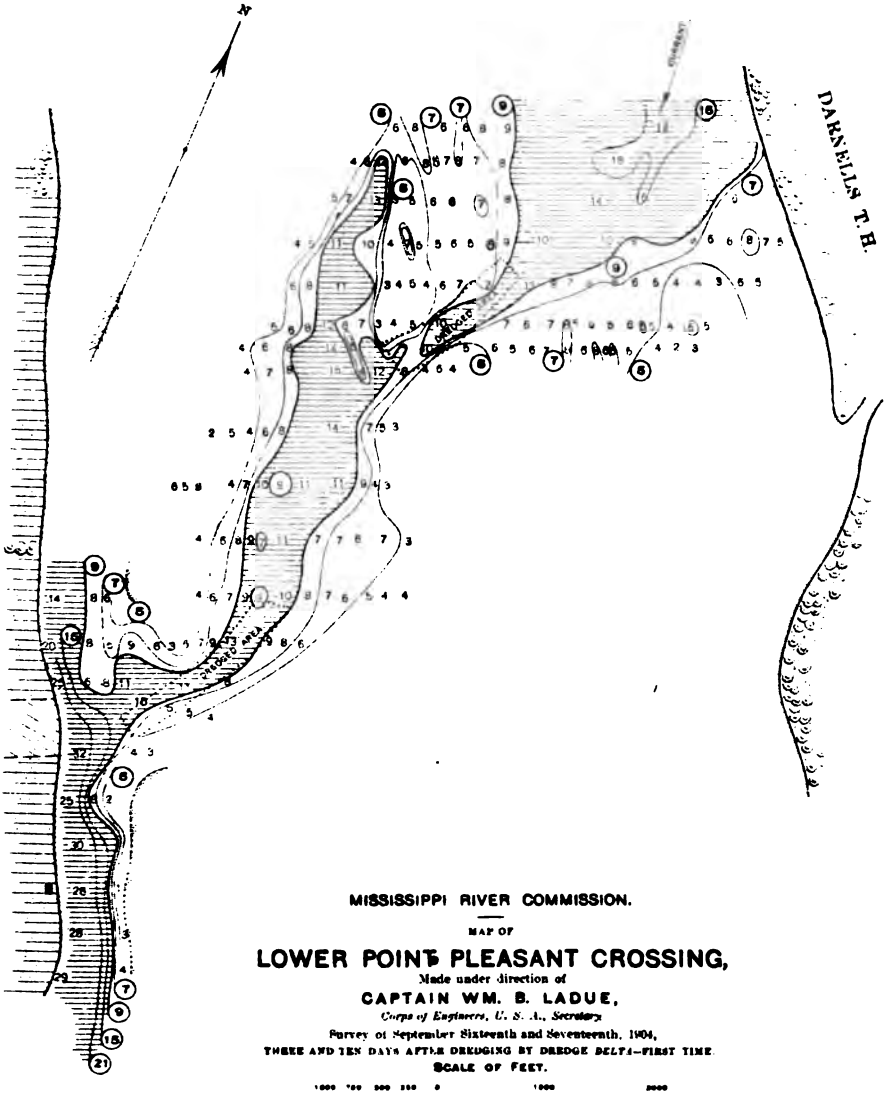

MISSISSIPPI RIVER COMMISSION.

MAP OF

LOWER POINT PLEASANT CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary

Survey of September Sixteenth and Seventeenth, 1904,

THREE AND TEN DAYS AFTER DREDGING BY DREDGE *DELTA*—FIRST TIME.

SCALE OF FEET.

1000 500 000 000 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid, M. R. C. gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 6.8 & 6.4 feet or 3.2 & 3.0 feet above mean low water.

Dotted areas indicate bars above mean low water

ANDREW B. GRAHAM CO. PHOTO-LITHOGRAPHERS WASHINGTON D.C.

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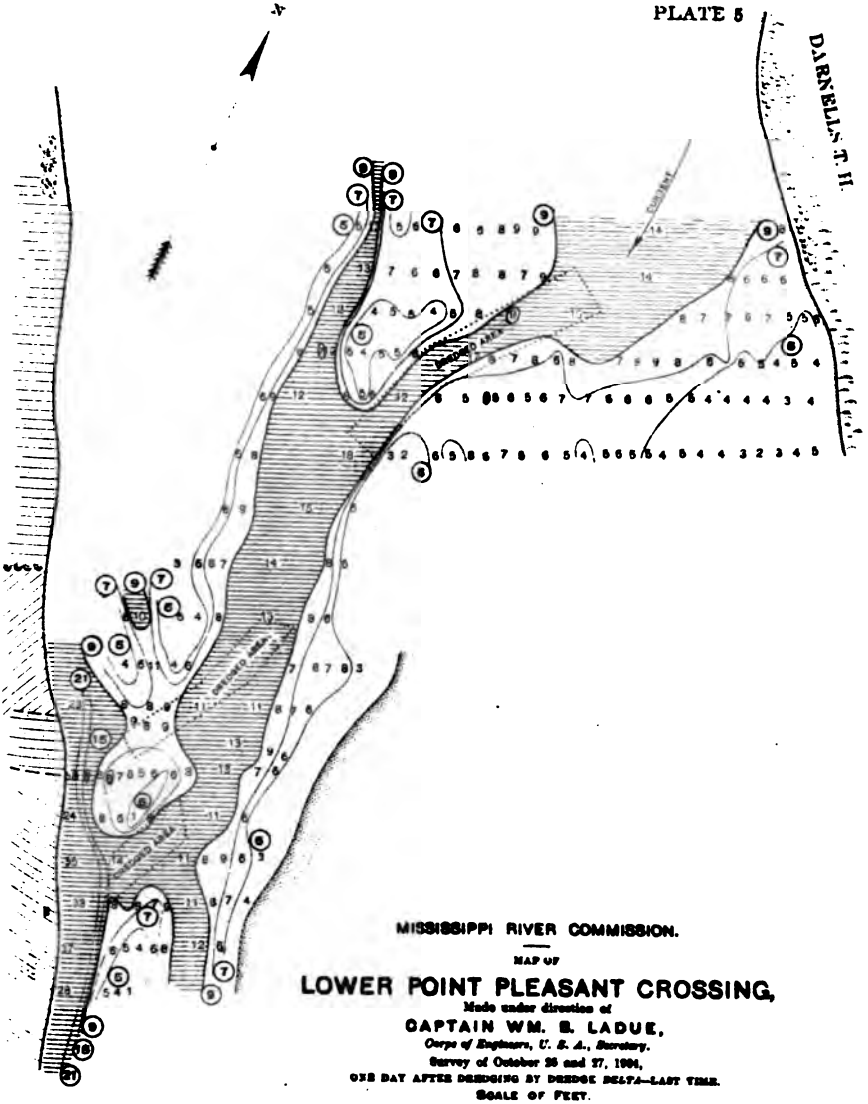
PLATE 5



MISSISSIPPI RIVER COMMISSION.

MAP OF

LOWER POINT PLEASANT CROSSING,

Made under direction of

CAPTAIN WM. H. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 26 and 27, 1904,

ONE DAY AFTER DREDGING BY DREDGE DELTA—LAST TIME.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid, M. R. C. gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 5.2 & 5.4 feet or 1.8 & 2.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

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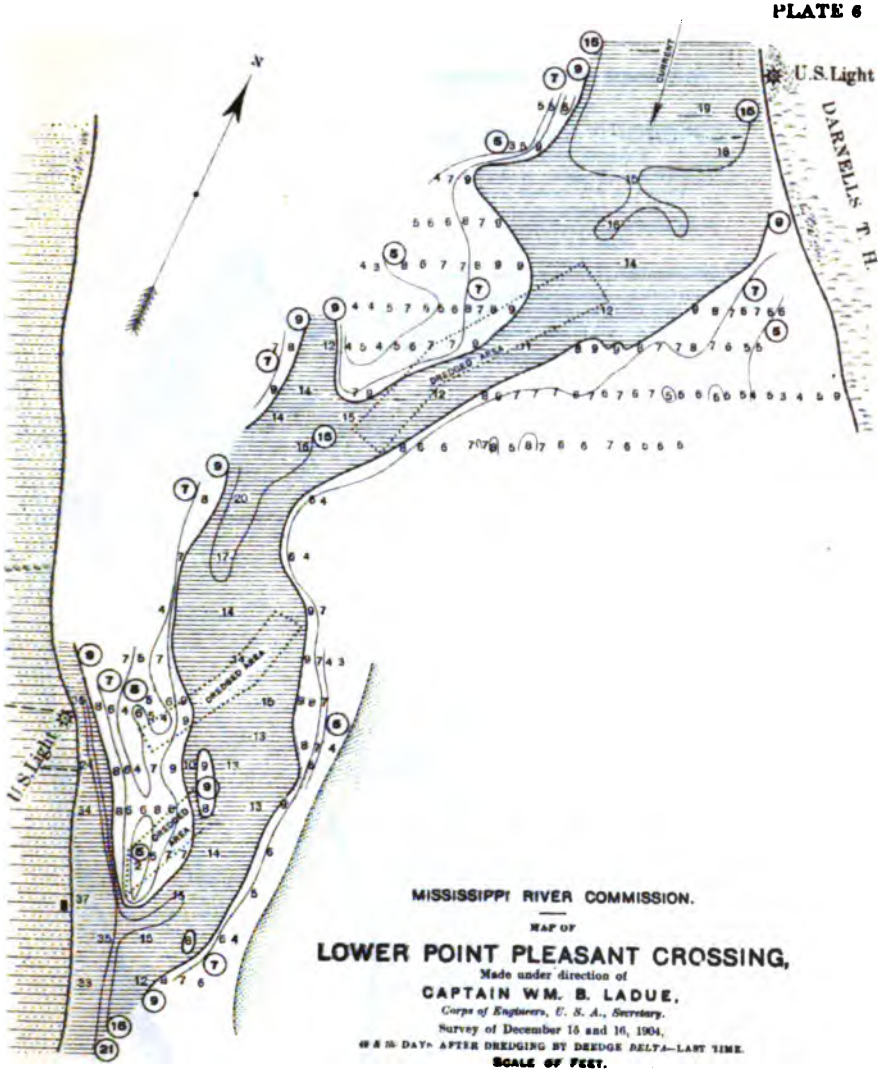

MISSISSIPPI RIVER COMMISSION.

MAP OF

LOWER POINT PLEASANT CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of December 15 and 16, 1904,

48 & 55 DAYS AFTER DREDGING BY DREDGE *DELTA*—LAST TIME.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid, M. R. C. gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 4.4 & 4.7 feet or 1.0 & 1.3 feet above mean low water.

Dotted areas indicate bars above mean low water.

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MISSISSIPPI RIVER COMMISSION.

MAP OF

JOE ECKLES CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 2, 1904,

17 DAYS BEFORE DREDGING BY DREDGE DELPH.

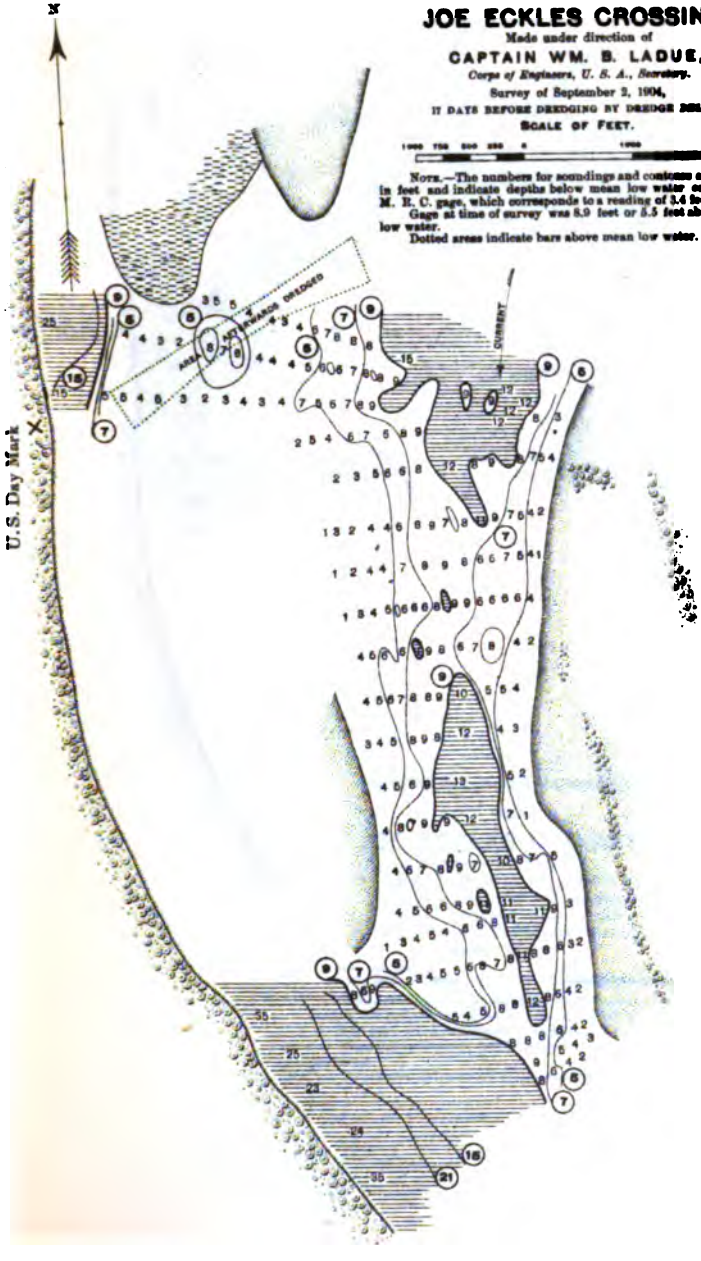
SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid, M. R. C. gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 8.9 feet or 5.5 feet above mean low water.

Dotted areas indicate bars above mean low water.



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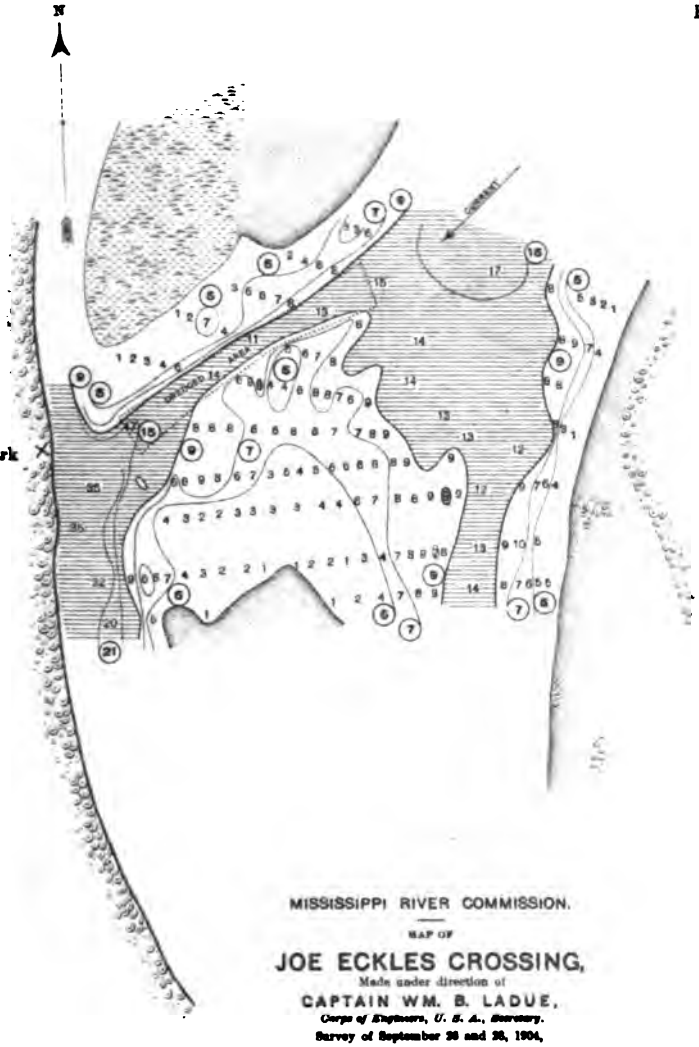

MISSISSIPPI RIVER COMMISSION.

MAP OF

JOE ECKLES CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 26 and 28, 1904,

JUST AFTER DREDGING BY DREDGE DELTA.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid, M. R. C. gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 9.4 & 8.9 feet or 6.0 & 5.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

HERMAN & GRAHAM CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

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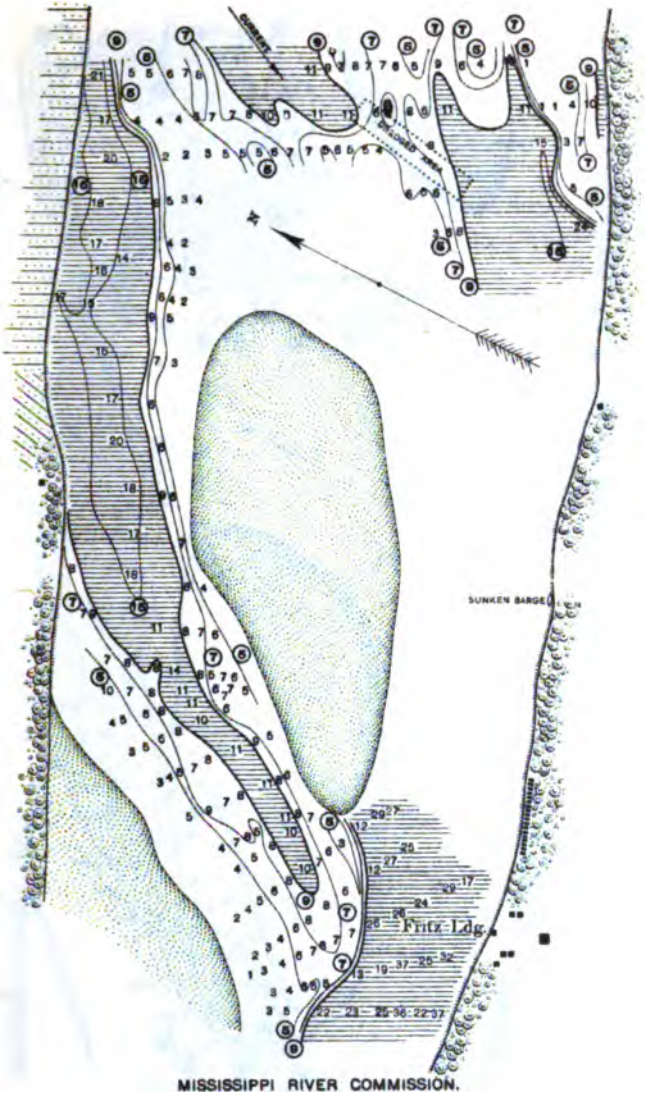
PLATE 9

ISLAND 14



MISSISSIPPI RIVER COMMISSION.

MAP OF

REELFOOT CROSSING,

Made under direction of

CAPTAIN WM. H. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 14 and 15, 1904,

SIX DAYS AFTER DREDGING BY DREDGE *HENRY FLAD.*

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid, M. R. O. gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 6.8 & 6.4 feet or 3.3 & 3.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

ANDREW F. BRAUN CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

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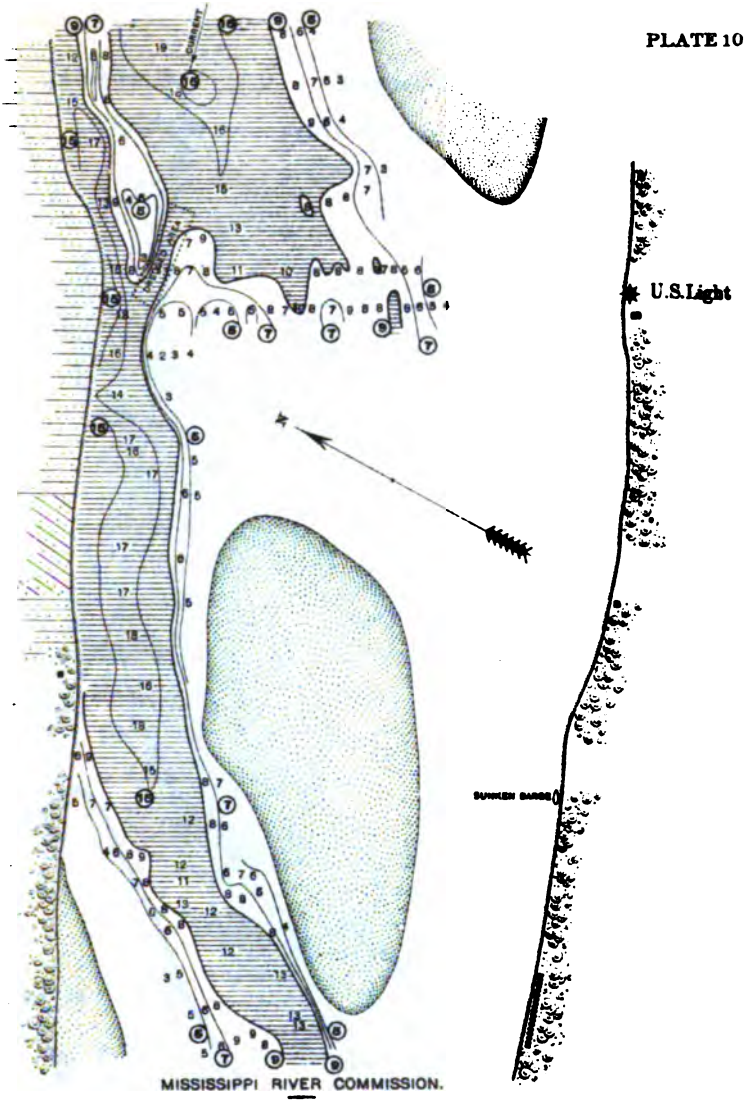
PLATE 10



MISSISSIPPI RIVER COMMISSION.

MAP OF

REELFOOT CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Surveyor.

Survey of October 21 and 22, 1904,

FOUR DAYS AFTER DREDGING BY DREDGE HENRY FLAD.

SCALE OF FEET.

1000 700 500 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid, M. R. C. gage, which corresponds to a reading of 3.4 feet.

Gage at time of survey was 5.4 feet or 2.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

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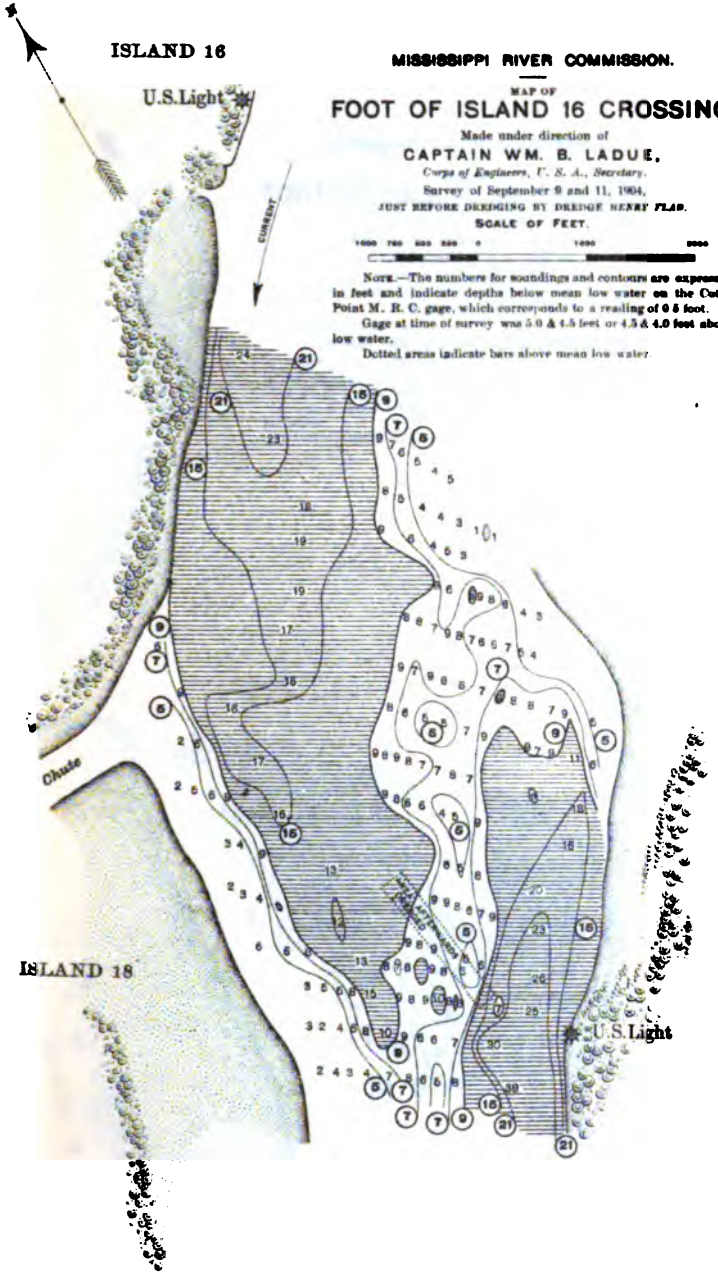

MISSISSIPPI RIVER COMMISSION.

MAP OF

FOOT OF ISLAND 16 CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 9 and 11, 1904,

JUST BEFORE DREDGING BY DREDGE HENRY FLAD.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point M. R. C. gage, which corresponds to a reading of 0.5 foot.

Gage at time of survey was 5.0 & 4.5 feet or 4.5 & 4.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

HEATH & GRAHAM CO., PHOTO-LITHOGRAPHERS WASHINGTON, D. C.

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MISSISSIPPI RIVER COMMISSION.

MAP OF

FOOT OF ISLAND 16 CROSSING,

Made under direction of

CAPTAIN WM. S. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 21, 1904,

SIX DAYS AFTER DREDGING BY DREDGE *HENRY FLAD.*

SCALE OF FEET.

1000 500 000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point M. R. C. gage, which corresponds to a reading of 0.5 feet.

Gage at time of survey was 4.0 feet or 3.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

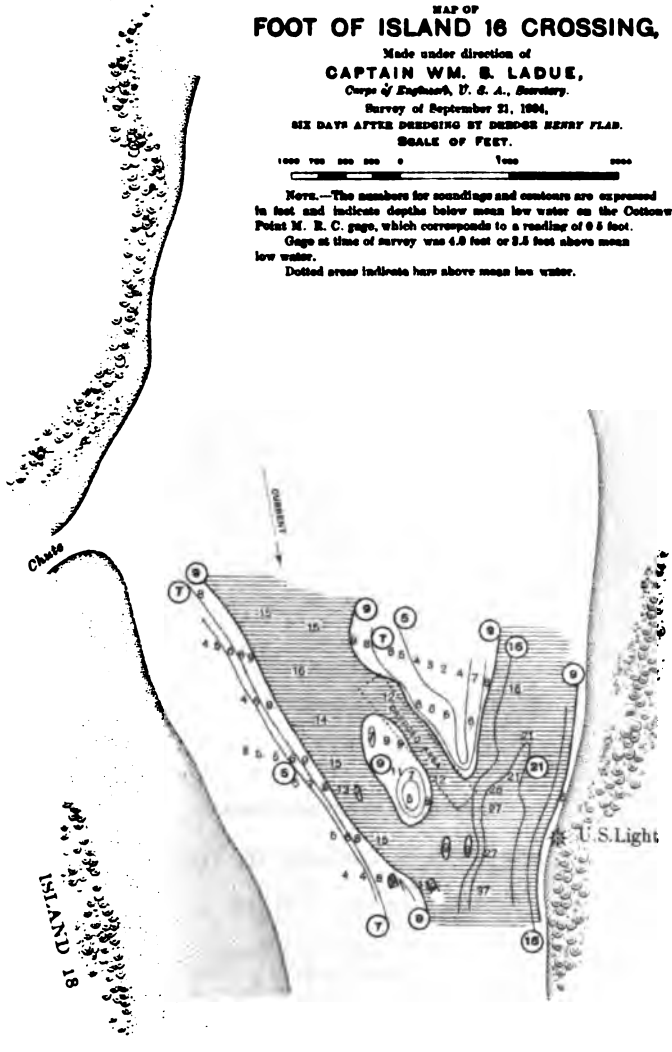

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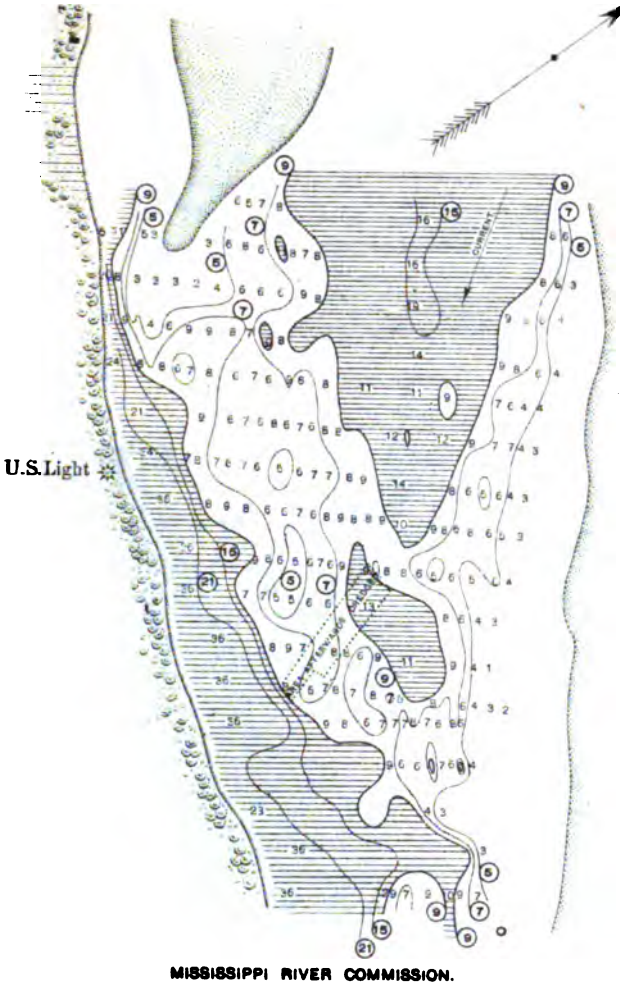
PLATE 13



MISSISSIPPI RIVER COMMISSION.

MAP OF

FOOT OF ISLAND 21 CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 9 and 10, 1904,

ONE DAY BEFORE DREDGING BY DREDGE *KAPPA*.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point M. R. C. gage, which corresponds to a reading of 0.5 foot.

Gage at time of survey was 4.0 & 5.0 feet or 4.3 & 4.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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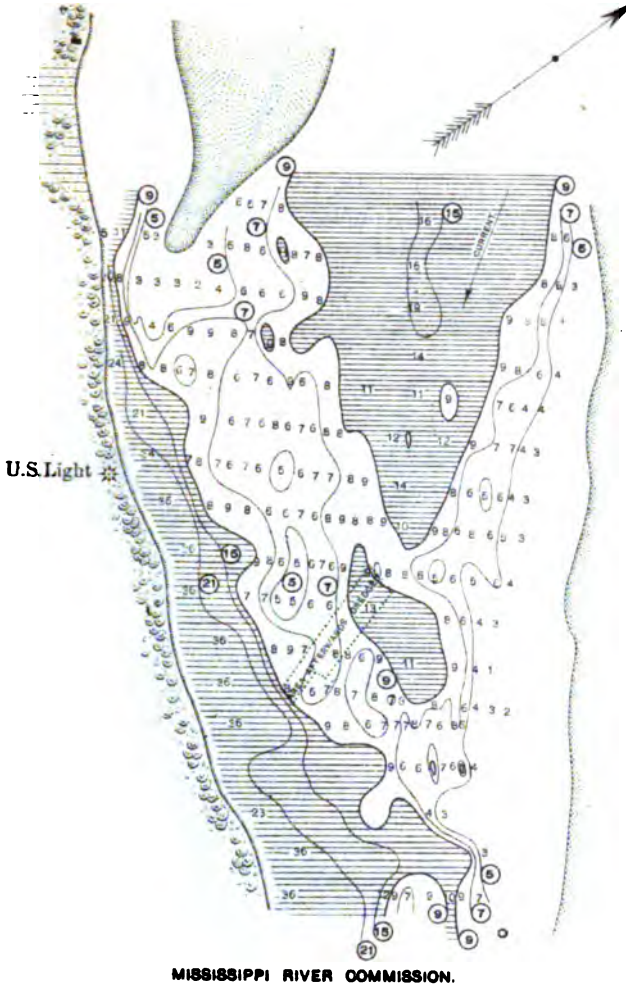
PLATE 13



MISSISSIPPI RIVER COMMISSION.

MAP OF

FOOT OF ISLAND 21 CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 9 and 10, 1904,

ONE DAY BEFORE DREDGING BY DREDGE *KAPPA*.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point M. R. C. gage, which corresponds to a reading of 0.5 foot. Gage at time of survey was 4.5 & 5.0 feet or 4.3 & 4.8 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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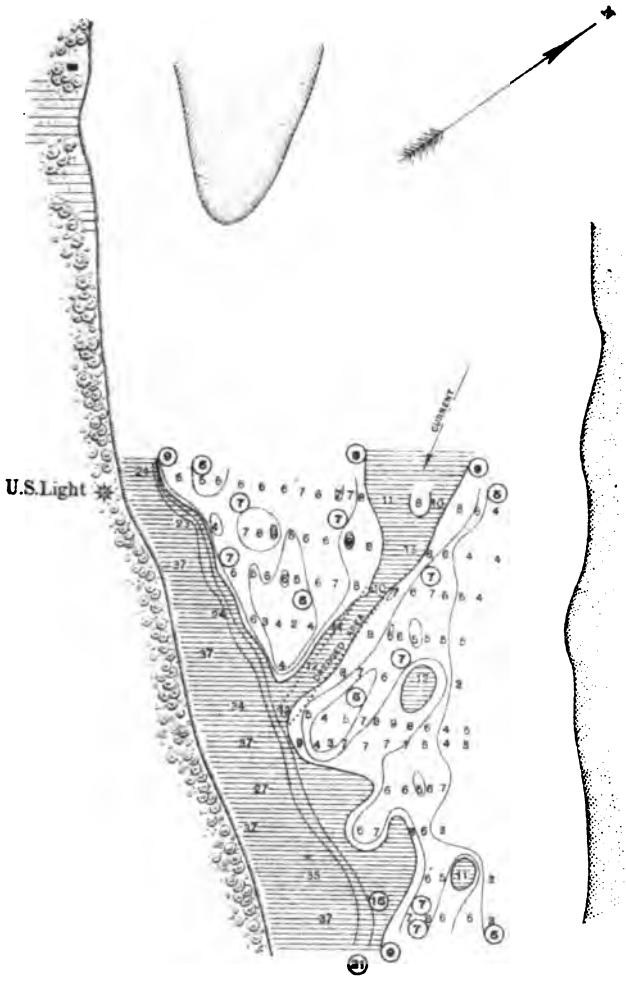
PLATE 14



MISSISSIPPI RIVER COMMISSION.

MAP OF

FOOT OF ISLAND 21 CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 20, 1904,

FIVE DAYS AFTER DREDGING BY DREDGE *KAPPA.*

SCALE OF FEET.

1000 500 000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point M. R. C. gage, which corresponds to a reading of 0.5 foot.

Gage at time of survey was 3.5 feet or 3.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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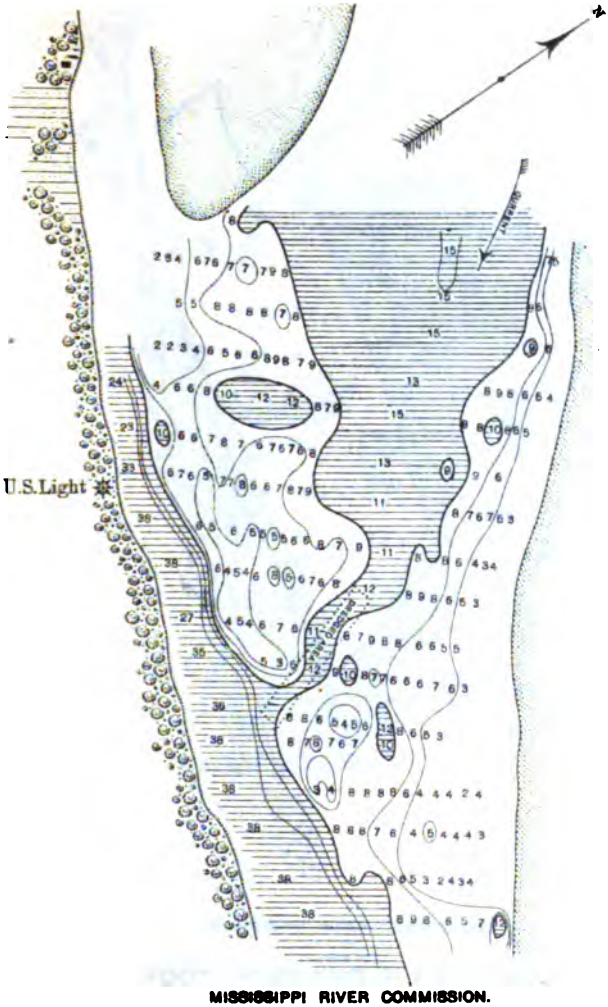
PLATE 15



MISSISSIPPI RIVER COMMISSION.

MAP OF

FOOT OF ISLAND 21 CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 20, 1904.

FOUR DAYS BEFORE DREDGING BY DREDGE *HENRY FLAD.*

SCALE OF FEET.

1000 500 000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point M. R. C. gage, which corresponds to a reading of 0.5 foot.

Gage at time of survey was 2.7 feet or 2.2 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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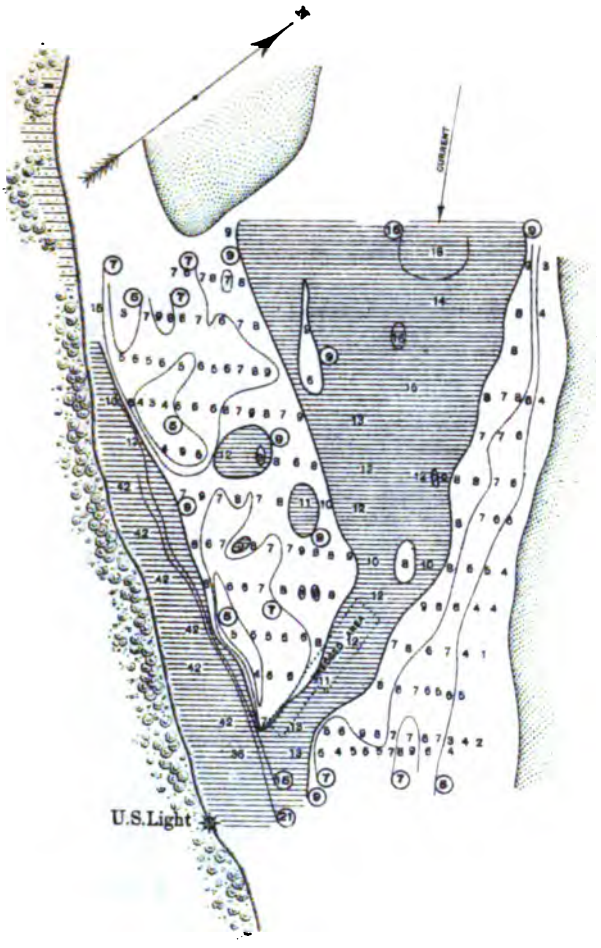

MISSISSIPPI RIVER COMMISSION.

MAP OF

FOOT OF ISLAND 21 CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Surveyor.

Survey of November 19, 1904,

12 DAYS AFTER DREDGING BY DREDGE HENRY FLAD.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point M. R. C. gage, which corresponds to a reading of 0.5 feet. Gage at time of survey was 3.5 feet or 3.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

BYRON S. ADAMS CO., PHOTO-LITHOGRAPHERS WASHINGTON, D. C.

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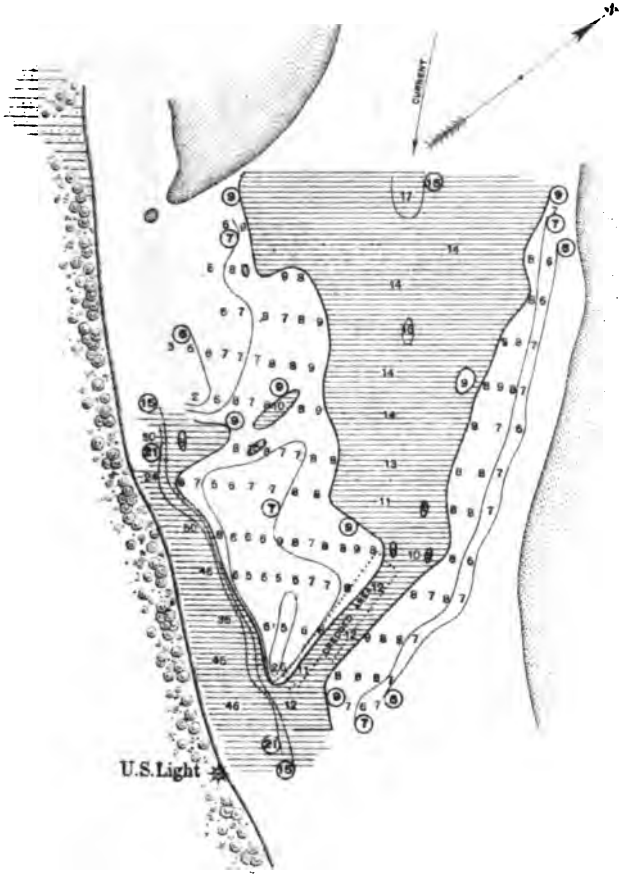
PLATE 17



MISSISSIPPI RIVER COMMISSION.

MAP OF

FOOT OF ISLAND 21 CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of December 9, 1904,

at DAYS AFTER DREDGING BY DREDGE *RIVER FLAG*.

SCALE OF FEET.

1000 500 000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point M. R. C. gage, which corresponds to a reading of 0.5 foot.

Gage at time of survey was 0.9 foot or 0.4 foot above mean low water.

Dotted areas indicate bars above mean low water.

... CO PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

Eng 59 1

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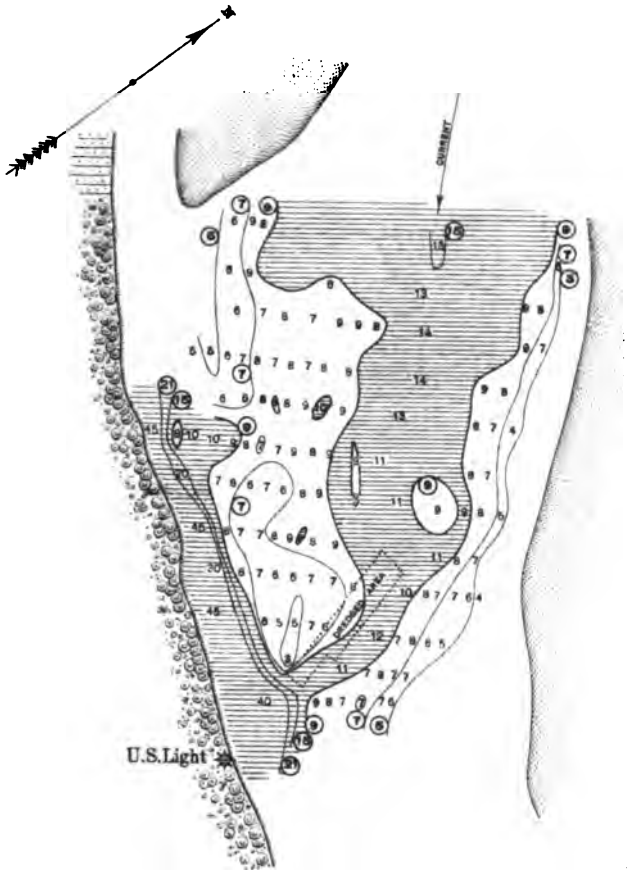

MISSISSIPPI RIVER COMMISSION.

MAP OF

FOOT OF ISLAND 21 CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of December 20, 1904,

10 DAYS AFTER DREDGING BY DREDGE *HENRY FLAD.*

SCALE OF FEET.

1000 500 000 000 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Cottonwood Point M. R. C. gage, which corresponds to a reading of 0.5 foot.

Gage at time of survey was 0.2 foot or 0.3 foot below mean low water.

Dotted areas indicate bars above mean low water.

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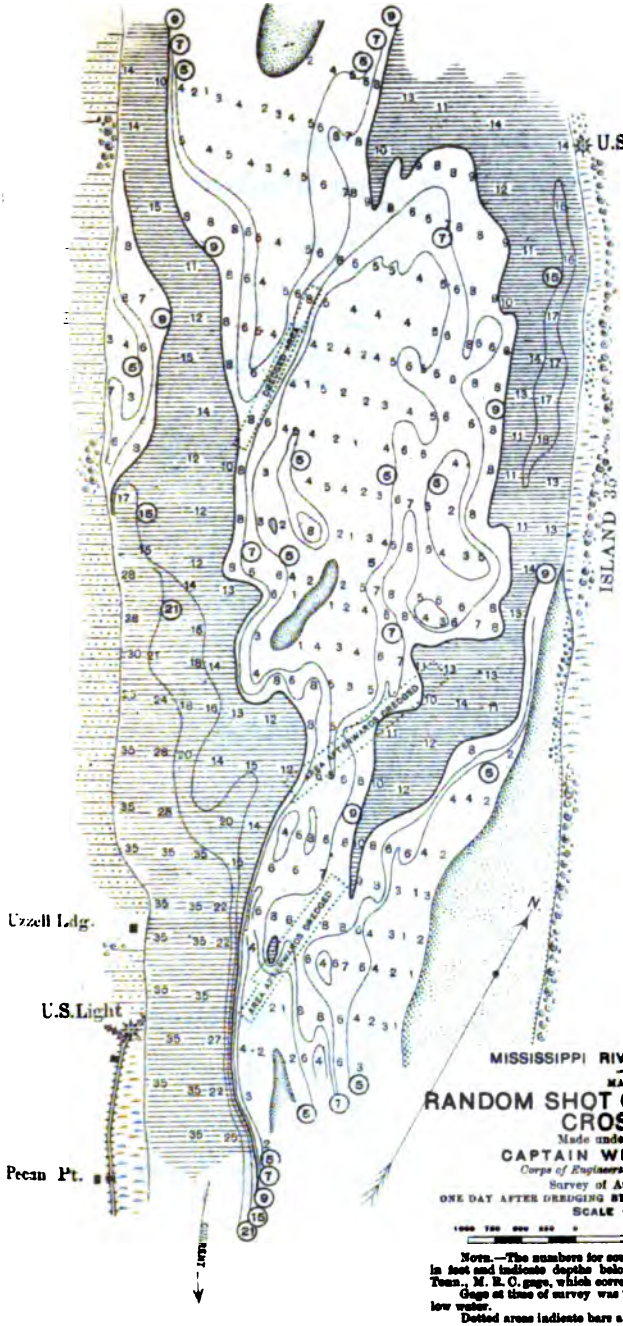

MISSISSIPPI RIVER COMMISSION.

MAP OF

RANDOM SHOT OR PECAN POINT CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of August 27, 1904.

ONE DAY AFTER DREDGING BY DREDGE *KAPPA*—(UPPER AREA.)

SCALE OF FEET.

1000 500 000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Texas., M. R. C. gage, which corresponds to a reading of 3.5 feet.

Gage at time of survey was 9.9 feet or 5.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

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MISSISSIPPI RIVER COMMISSION.

MAP OF

RANDOM SHOT OR PECAN POINT CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 4, 1904,

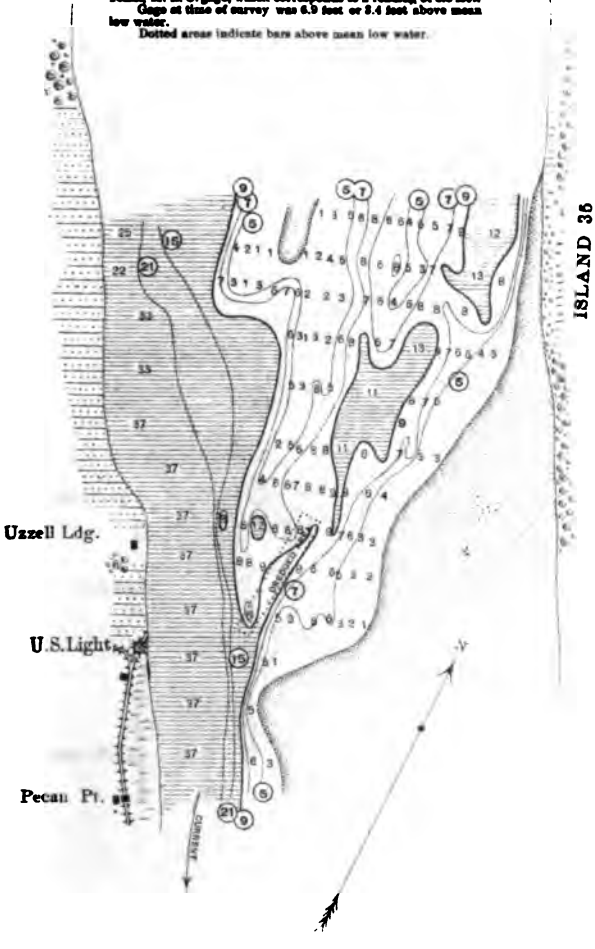
ONE DAY AFTER DREDGING BY DREDGE KAPPA—(LOWER AREA.)

SCALE OF FEET.

1000 500 0 1000 2000

Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Tenn., M. R. C. gage, which corresponds to a reading of 3.5 feet. Gage at time of survey was 6.9 feet or 3.4 feet above mean low water.

Dotted areas indicate bars above mean low water.



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MISSISSIPPI RIVER COMMISSION.

MAP OF

RANDOM SHOT OR PECAN POINT CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 17, 1904,

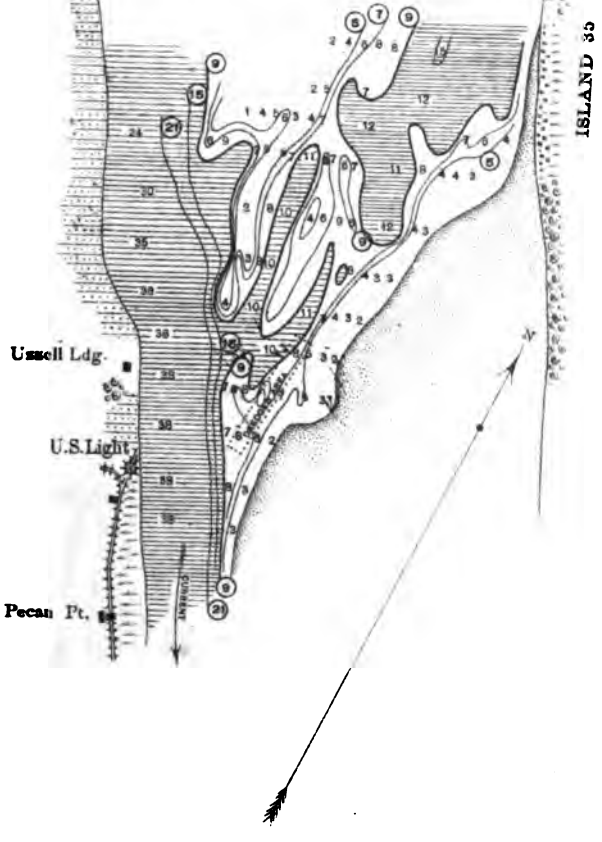
10 DAYS AFTER DREDGING BY DREDGE KAPPA—(LOWER AREA.)

SCALE OF FEET.

1000 500 000 000 0 2000 4000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Tenn., M. R. C. gage which corresponds to a reading of 3.5 feet. Gage at time of survey was 5.2 feet or 1.7 feet below mean low water.

Dotted areas indicate bars above mean low water.



Eng 59 1

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MISSISSIPPI RIVER COMMISSION.

MAP OF

RANDOM SHOT OR PECAN POINT CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

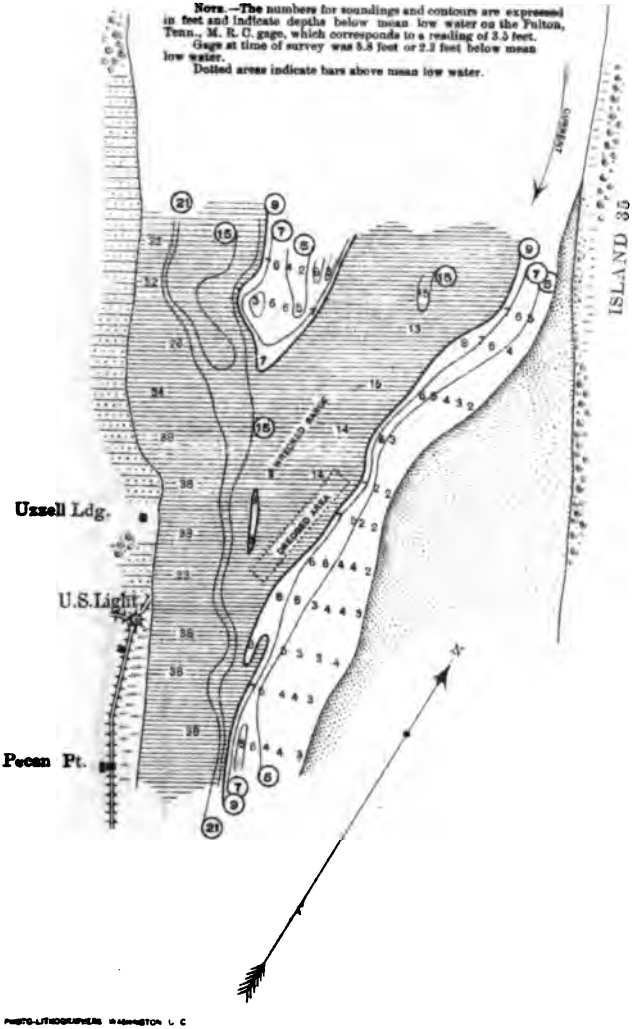
Corps of Engineers, U. S. A., Secretary.

Survey of October 12, 1904,

10 DAYS AFTER DREDGING BY DREDGE ZINGLER—(LOWER AREA.)

SCALE OF FEET.

1000 500 0 1000 2000


Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Tenn., M. R. C. gage, which corresponds to a reading of 3.5 feet.
Gage at time of survey was 5.8 feet or 2.3 feet below mean low water.
Dotted areas indicate bars above mean low water.
CURRENT
ISLAND 35
WRECKED BANK
DREDGED AREA
Uzzell Ldg.
U.S.Light
Pecan Pt.

OTTO H. KAHNWEILER CO. PHOTO-LITHOGRAPHERS WASHINGTON, D. C.

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MISSISSIPPI RIVER COMMISSION.

MAP OF

RANDOM SHOT OR PECAN POINT CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 27, 1904,

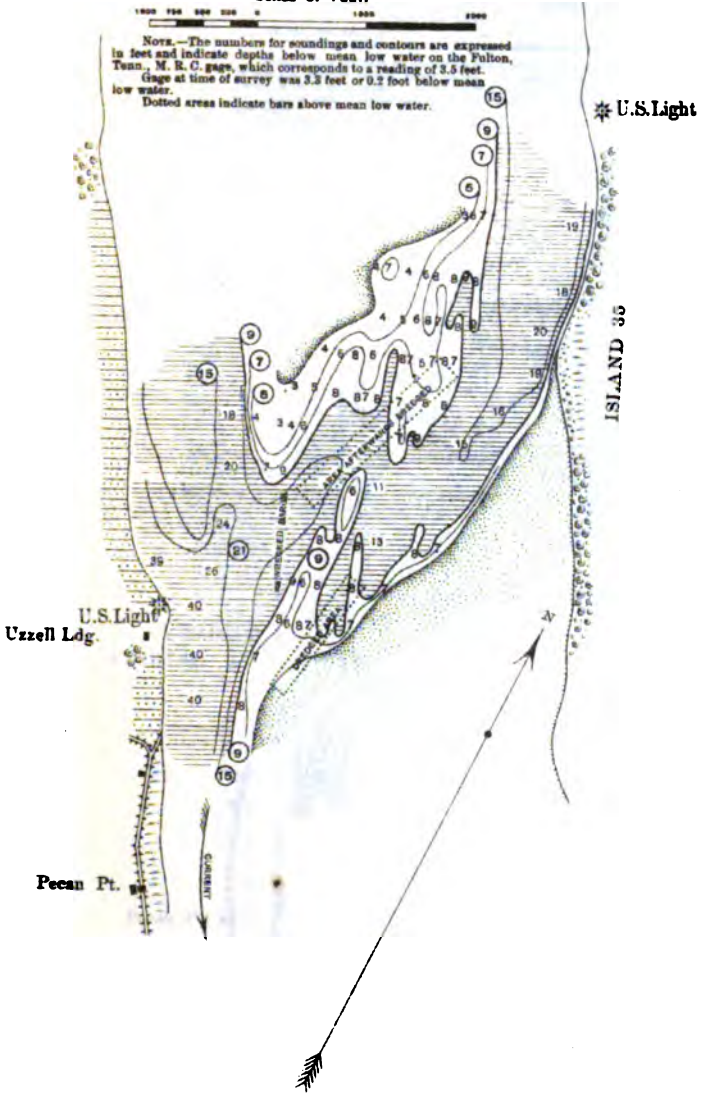
THREE DAYS BEFORE DREDGING BY DREDGE EPOLOS—MIDDLE AREA.)

SCALE OF FEET.

1500 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Tenn., M. R. C. gage, which corresponds to a reading of 3.5 feet. Gage at time of survey was 3.3 feet or 0.2 foot below mean low water.

Dotted areas indicate bars above mean low water.



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MISSISSIPPI RIVER COMMISSION.

MAP OF

RANDOM SHOT OR PECAN POINT CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of December 5, 1904,

ONE DAY AFTER DEPOSITING ST DENNIS SPURS.—(MIDDLE AREA.)

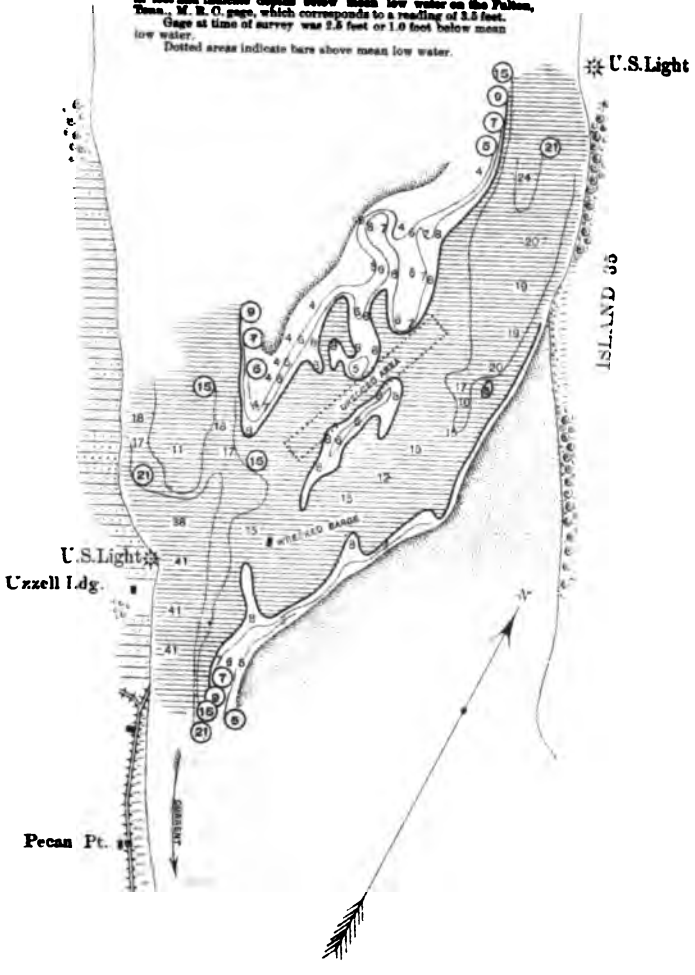
SCALE OF FEET.

1000 500 000 000 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Texas, M. R. G. gage, which corresponds to a reading of 3.5 feet.

Gage at time of survey was 2.5 feet or 1.0 foot below mean low water.

Dotted areas indicate bars above mean low water.



Eng 59 1

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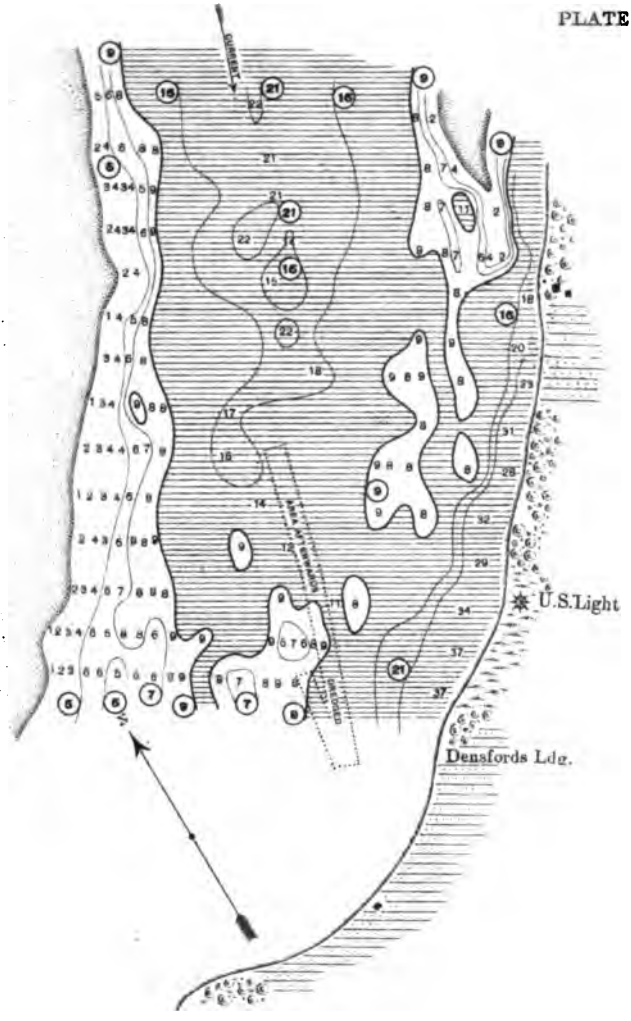

MISSISSIPPI RIVER COMMISSION.

MAP OF

DENSFORDS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 30, 1904,

15 DAYS BEFORE DREDGING BY DREDGE *PITTSBURG*.

SCALE OF FEET.

1000 700 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Tenn., M. R. C. gage, which corresponds to a reading of 3.5 feet.

Gage at time of survey was 7.0 feet or 3.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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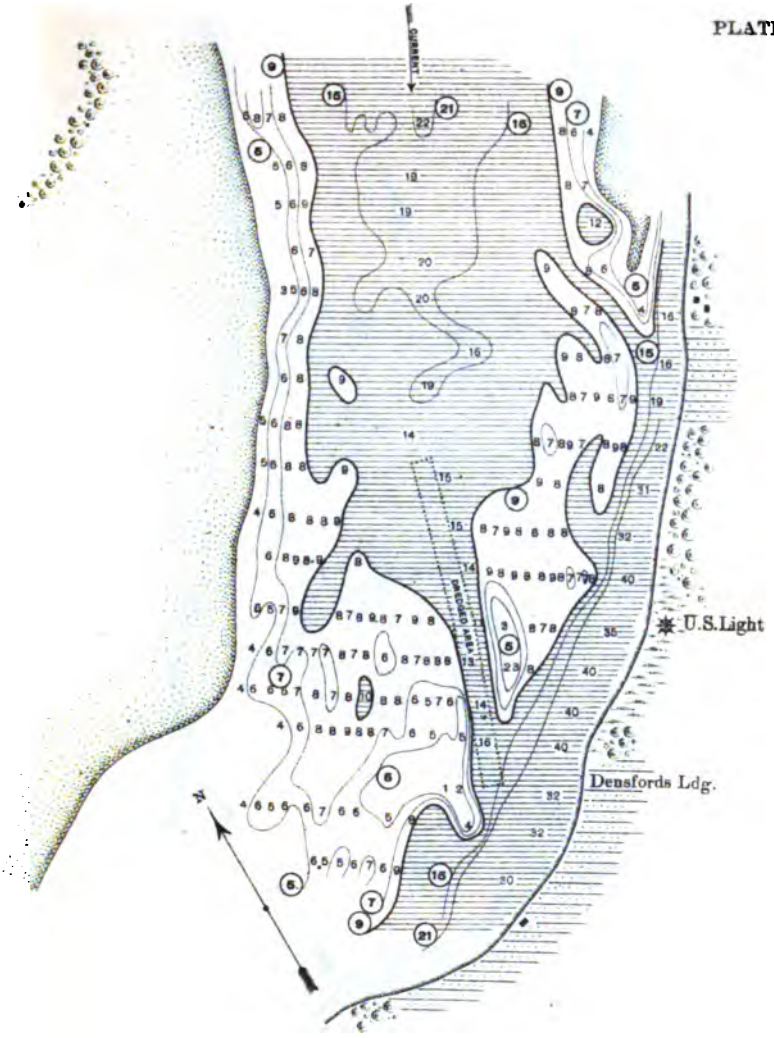

MISSISSIPPI RIVER COMMISSION.

MAP OF

DENSFORDS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 24, 1904,

ONE DAY AFTER DREDGING BY DREDGE *EPOLON*—FIRST TIME.

SCALE OF FEET.

1000 500 000 000 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Tenn., M. R. C. gage, which corresponds to a reading of 3.5 feet.

Gage at time of survey was 3.5 feet or 0.5 foot above mean low water.

Dotted areas indicate bars above mean low water.

ANDREW B. GRAHAM CO. PHOTO-LITHOGRAPHERS. WASHINGTON, D. C.

Eng 59 1

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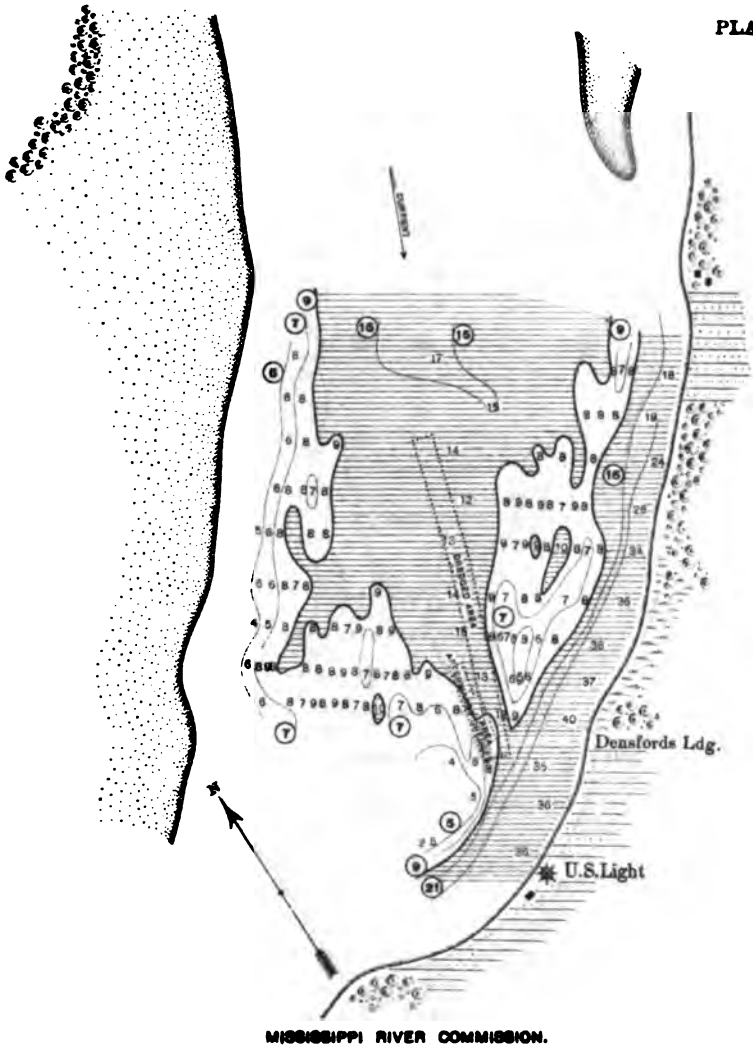

MISSISSIPPI RIVER COMMISSION.

MAP OF

DENSFORDS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of December 4, 1904,

FOUR DAYS BEFORE DREDGING BY DREDGE EPHLIN—SECOND TIME.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Tenn., M. R. C. gage, which corresponds to a reading of 3.5 feet.

Gage at time of survey was 2.5 feet or 1.0 foot below mean low water.

Dotted areas indicate bare above mean low water.

JUDGE & DUNLAP CO. PHOTO-LITHOGRAPHERS WASHINGTON D. C.

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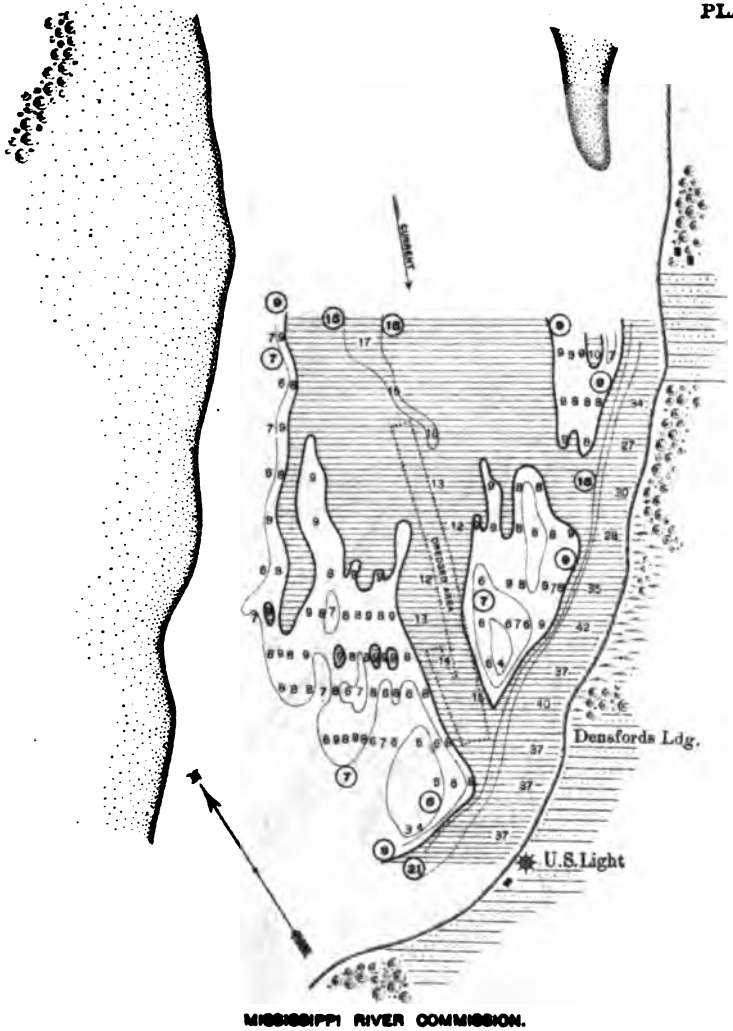

MISSISSIPPI RIVER COMMISSION.

MAP OF

DENSFORDS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of December 12, 1904,

ONE DAY AFTER DREDGING BY DREDGE ENGLIS—SECOND TIME.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Tenn., M. R. C. gage, which corresponds to a reading of 2.5 feet. Gage at time of survey was 2.0 feet or 1.5 feet below mean low water.

Dotted areas indicate bars above mean low water.

ENGR'G & SURVEY CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

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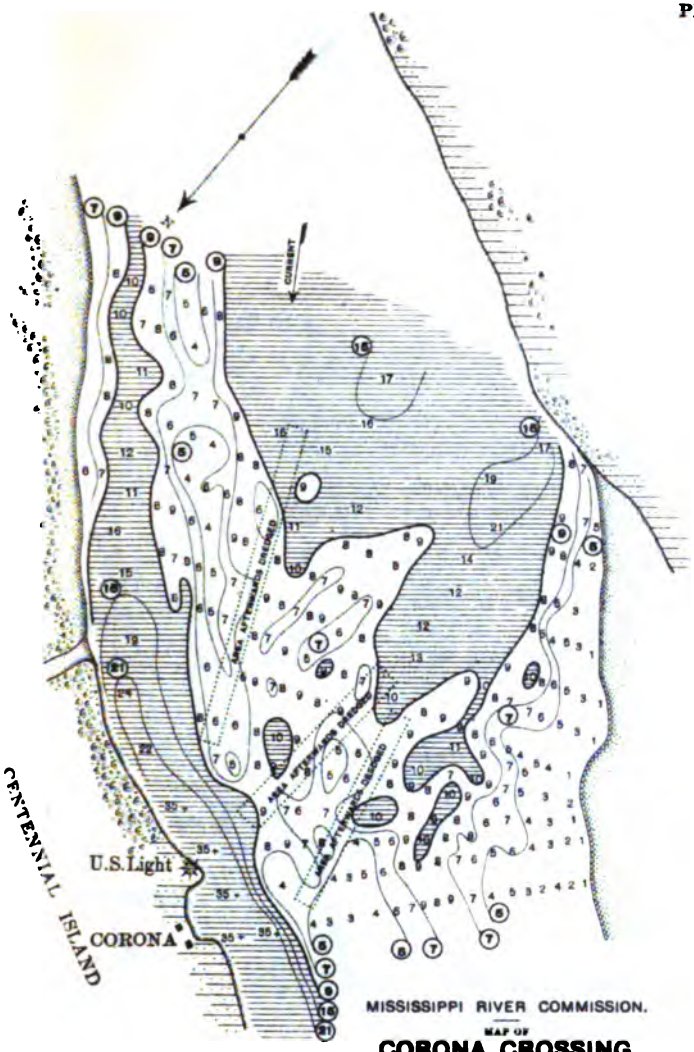

MISSISSIPPI RIVER COMMISSION.

MAP OF

CORONA CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of August 30, 1904,

JUST BEFORE DREDGING BY DREDGE ZETA.

SCALE OF FEET

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton Town...M. R. C. gage, which corresponds to a reading of 3.5 feet.

Gage at time of survey was 9.0 feet or 5.5 feet below mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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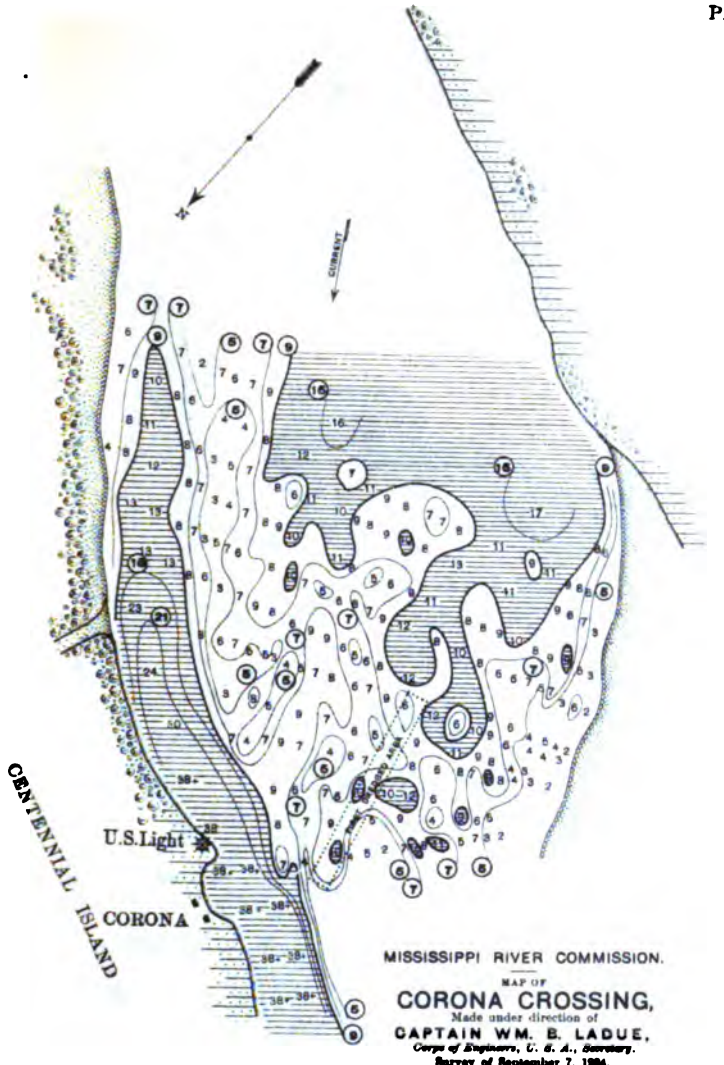

MISSISSIPPI RIVER COMMISSION.

MAP OF

CORONA CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 7, 1904,

THREE DAYS AFTER DREDGING DERRIDGE REFA.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Tenn., M. R. C. gage, which corresponds to a reading of 2.5 feet.

Gage at time of survey was 6.0 feet or 2.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

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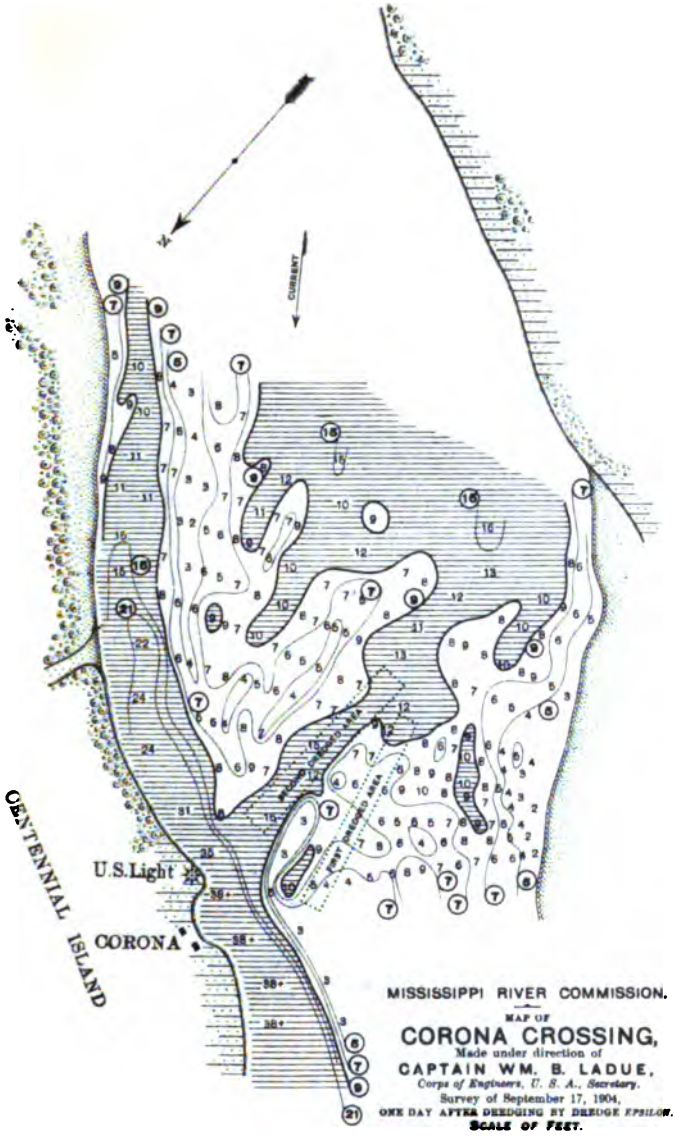

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Tenn., M. R. C. gage, which corresponds to a reading of 3.5 feet. Gage at time of survey was 5.2 feet or 1.7 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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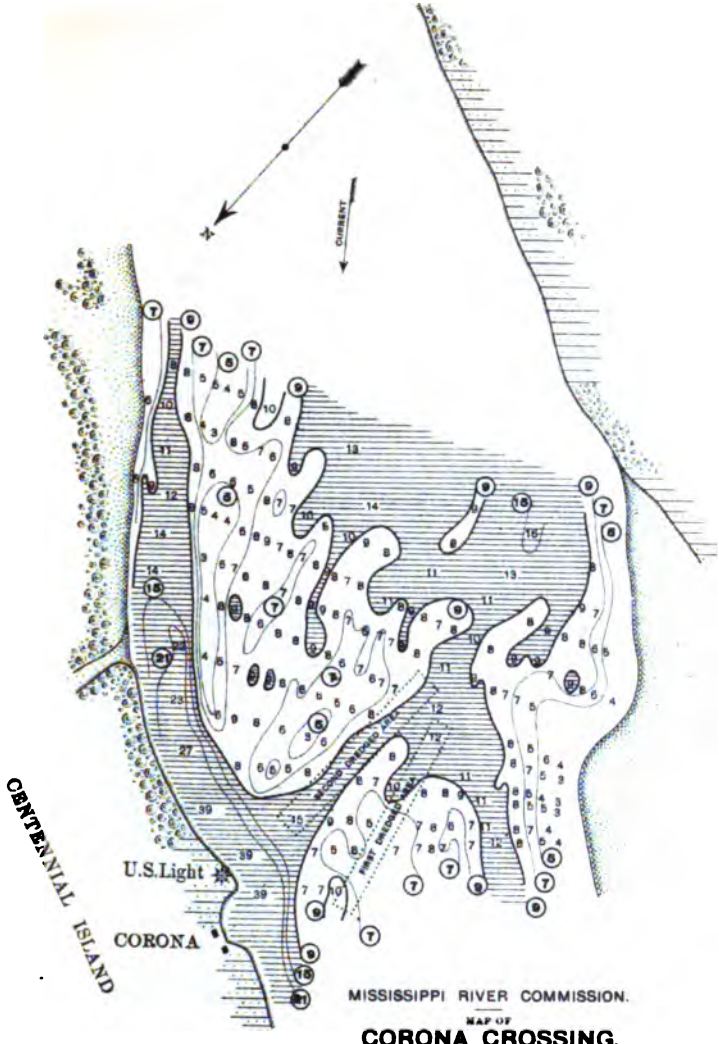

MISSISSIPPI RIVER COMMISSION.

MAP OF

CORONA CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 18, 1904,

24 DAYS AFTER DREDGING BY DREDGE EPSILON.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Texas, M. R. C. gage, which corresponds to a reading of 2.5 feet. Gage at time of survey was 4.5 feet or 0.5 foot above mean low water.

Dotted areas indicate bars above mean low water.

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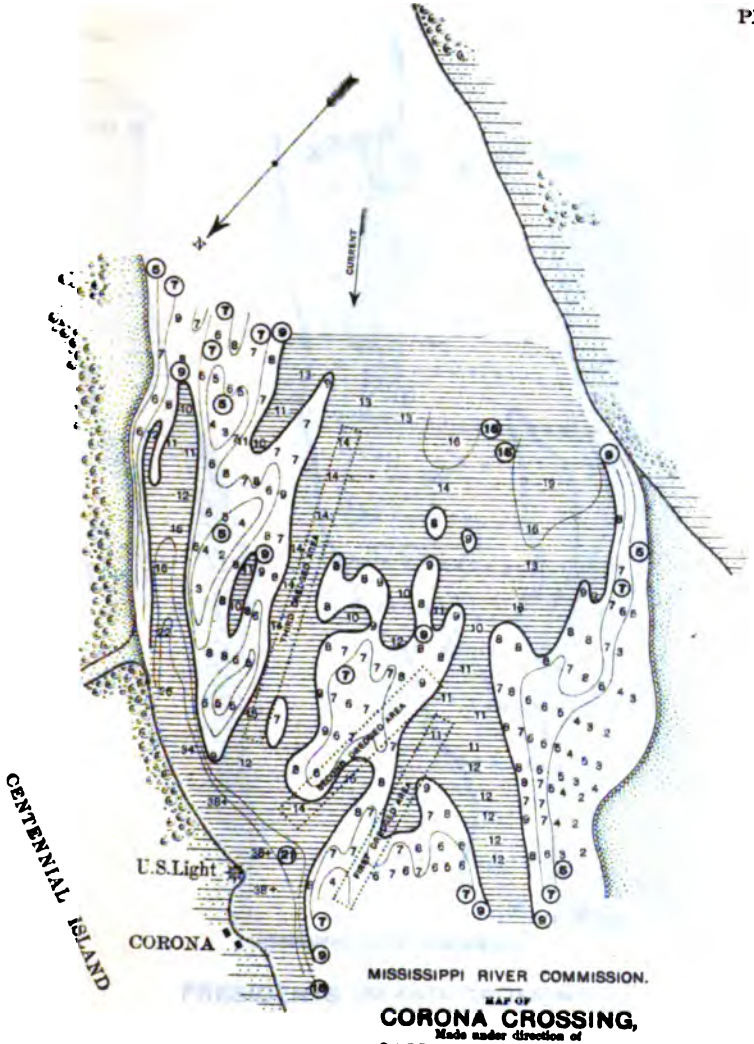
PLATE 33



MISSISSIPPI RIVER COMMISSION.

MAP OF

CORONA CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 5, 1904,

ONE DAY AFTER DREDGING BY DREDGE *EMSLOE*.

SCALE OF FEET.

1000 500 000 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Tenn., M. R. C. gage, which corresponds to a reading of 3.8 feet. Gage at time of survey was 5.7 feet or 7.2 feet above mean low water.

Dotted areas indicate bars above mean low water.

BYRON S. ADAMS CO. PHOTO-LITHOGRAPHERS WASHINGTON D. C.

Eng 59 1

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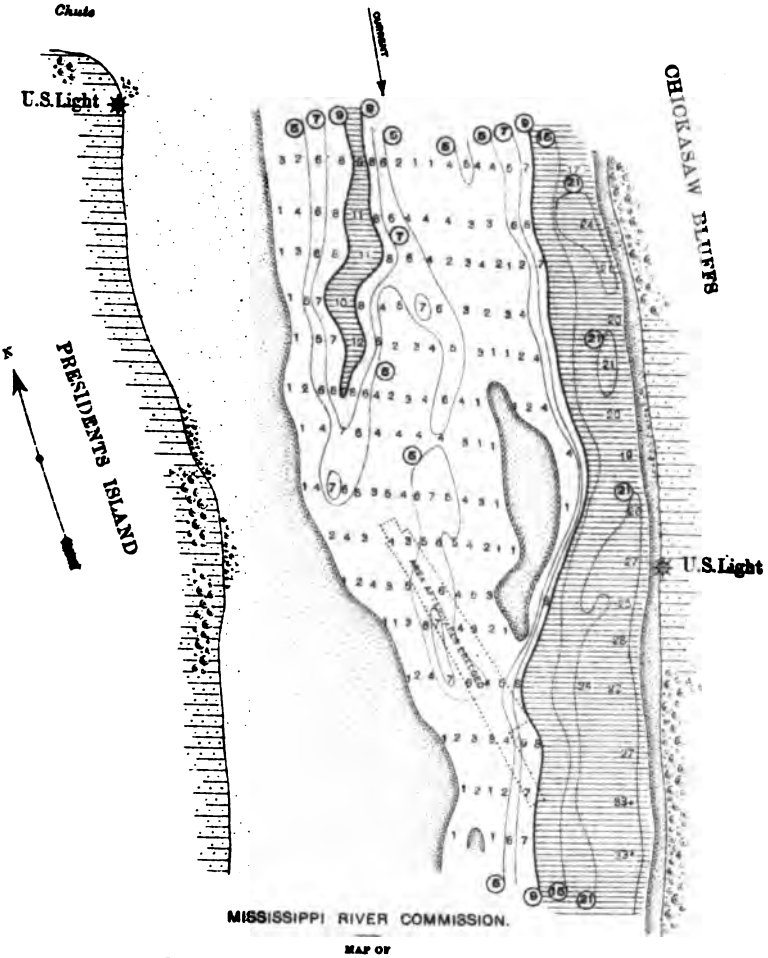
PLATE 34



MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 1, 1904,

ONE DAY BEFORE DREDGING BY DREDGE SPERLAN.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 foot.

Gage at time of survey was 7.5 feet or 6.6 feet above mean low water.

Dotted areas indicate bars above mean low water.

... U.S. PHOTO LITHOGRAPHERS, WASHINGTON, D. C.

Eng 59 1

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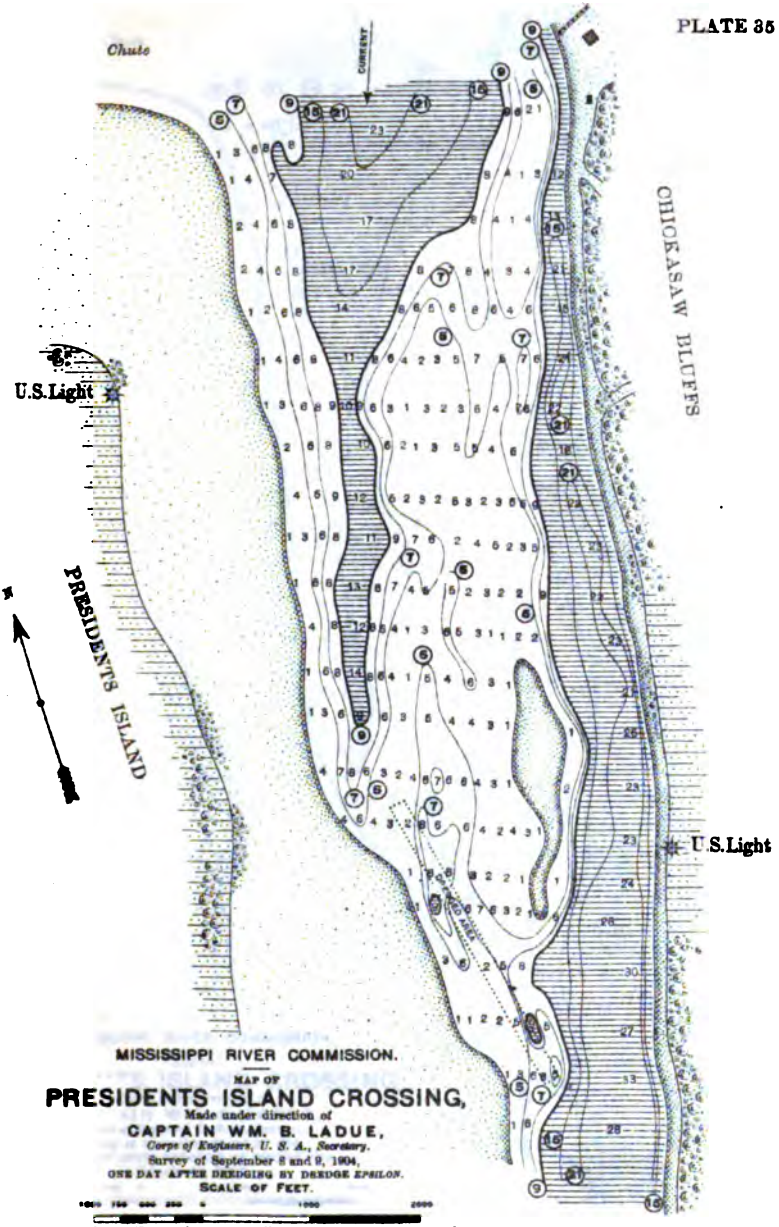
PLATE 35



NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.0 feet.

Gage at time of survey was 4.9 feet or 4.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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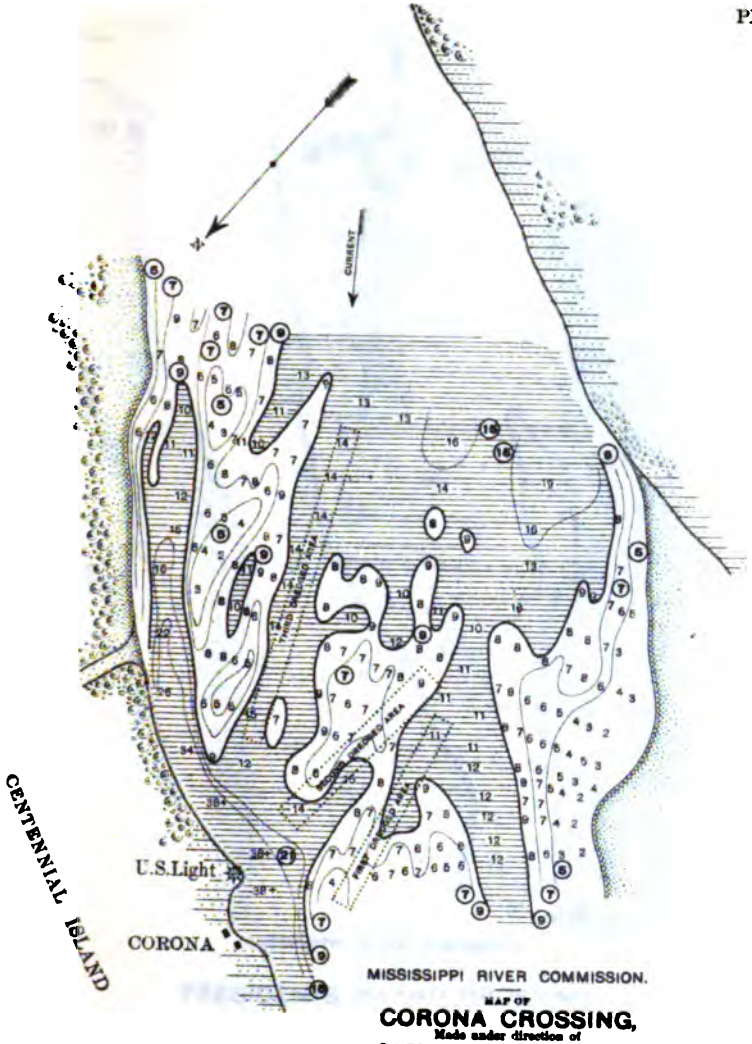
PLATE 33



MISSISSIPPI RIVER COMMISSION.

MAP OF

CORONA CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 5, 1904,

ONE DAY AFTER DREDGING BY DREDGE SPERLON.

SCALE OF FEET.

1000 700 600 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Fulton, Tenn., M. R. C. gage, which corresponds to a reading of 2.5 feet. Gage at time of survey was 5.7 feet or 7.2 feet above mean low water.

Dotted areas indicate bars above mean low water.

ARTHUR S. GRIGGS CO., PHOTO-LITHOGRAPHERS WASHINGTON D. C.

Eng 59 1

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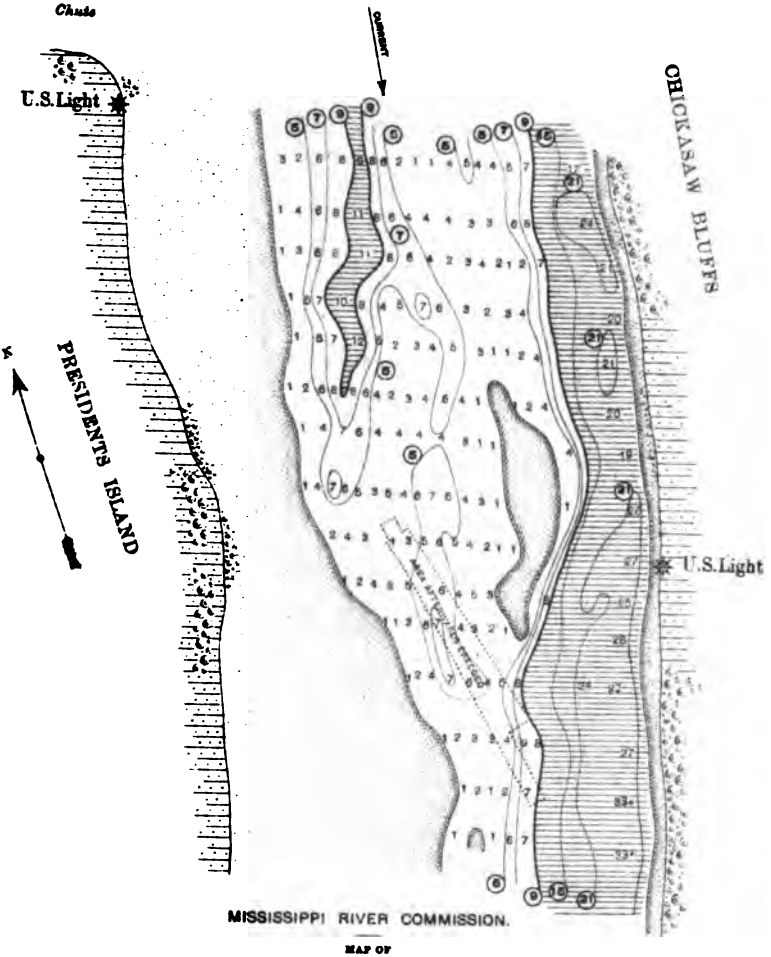

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 1, 1904,

ONE DAY BEFORE DREDGING BY DREDGE *SPERLON*.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 foot.

Gage at time of survey was 7.5 feet or 6.6 feet above mean low water.

Dotted areas indicate bars above mean low water.

JUDGE & DUNBAR LITH. CO., PHOTO LITHOGRAPHERS, WASHINGTON, D. C.

Eng 59 1

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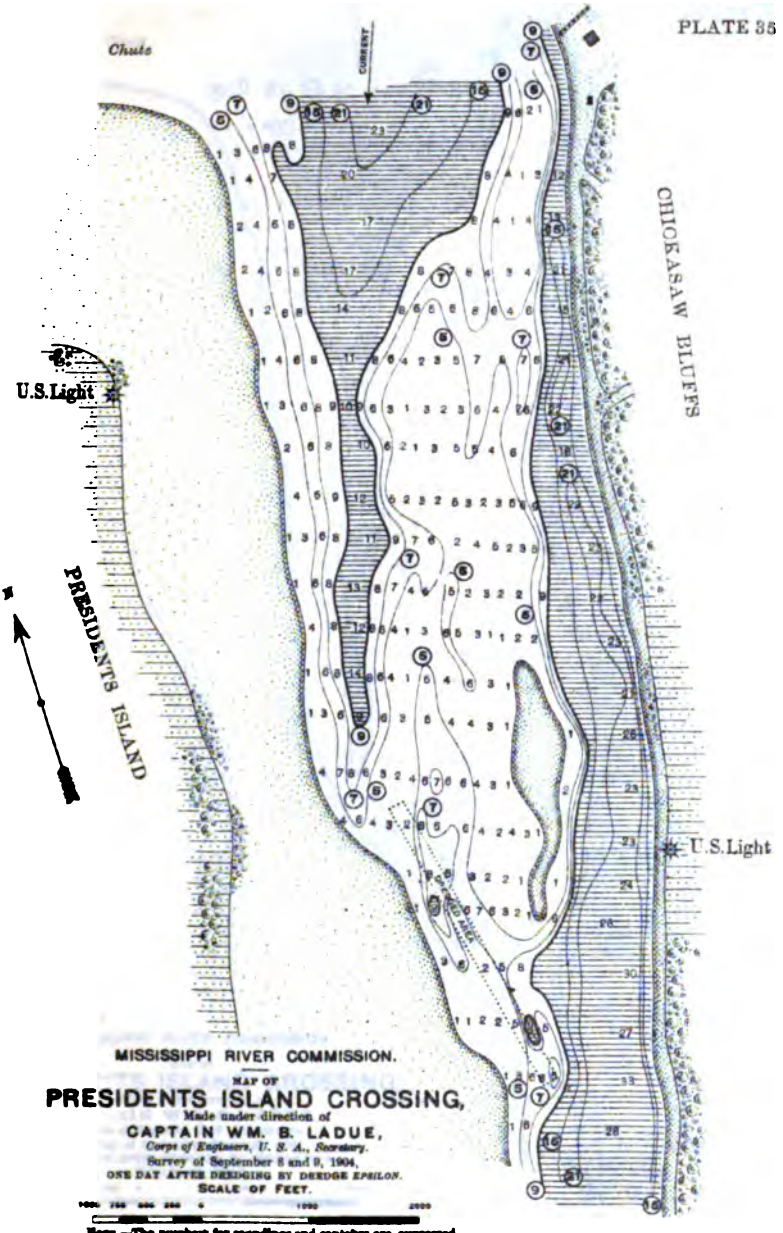
PLATE 35



MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 8 and 9, 1904,

ONE DAY AFTER DREDGING BY DREDGE *EPSILON*.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 feet.

Gage at time of survey was 4.9 feet or 4.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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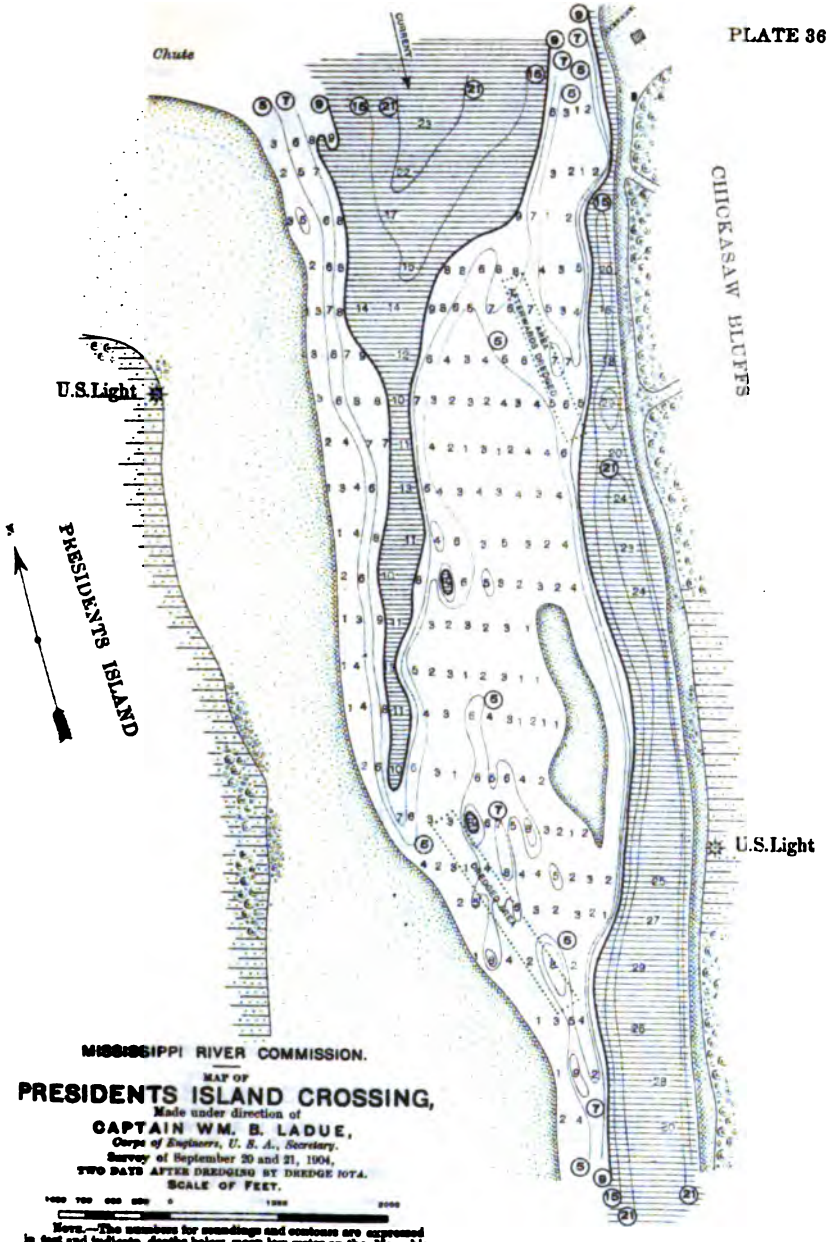
PLATE 36



MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 20 and 21, 1904.

TWO DAYS AFTER DREDGING BY DREDGE *NOTA.*

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 feet.

Gage at time of survey was 3.9 feet or 3.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

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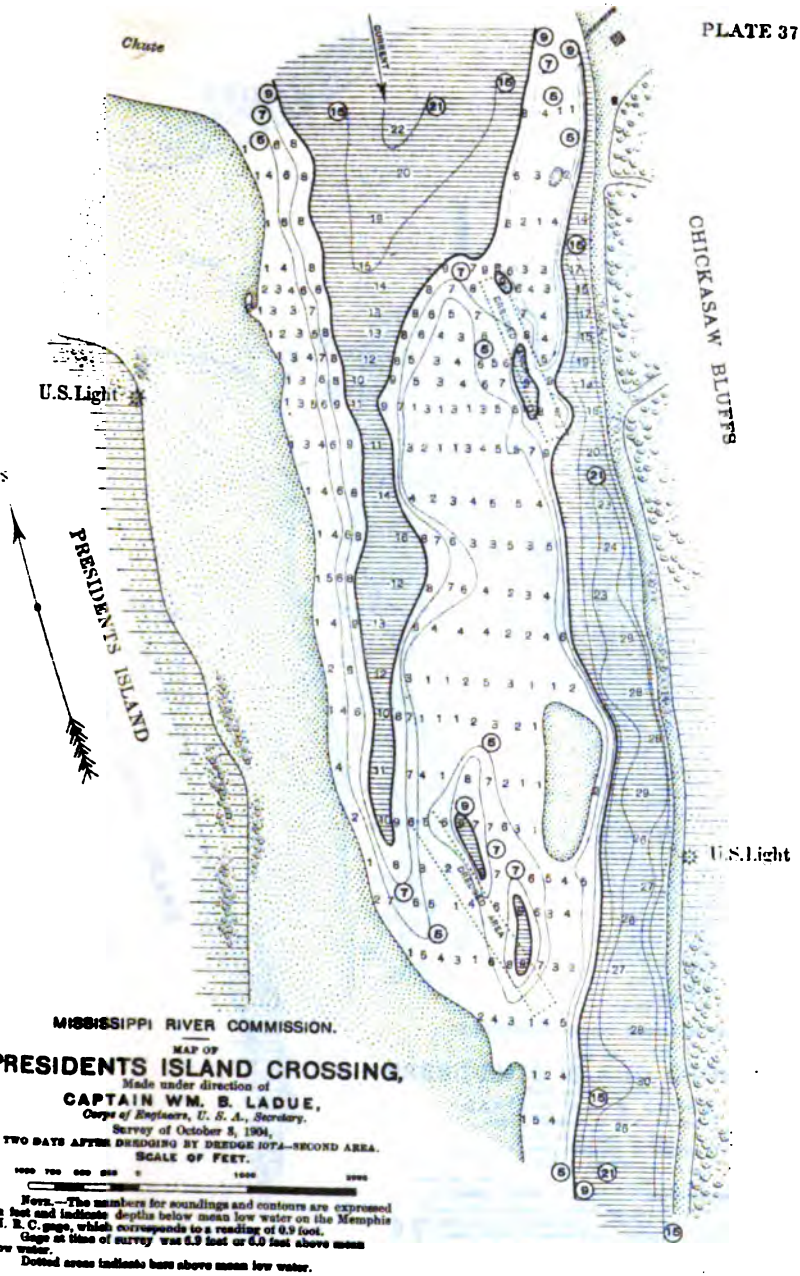
PLATE 37



MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 8, 1904,

TWO DAYS AFTER DREDGING BY DREDGE *IOTA*—SECOND AREA.

SCALE OF FEET.

1000 700 600 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 foot. Gage at time of survey was 6.9 feet or 6.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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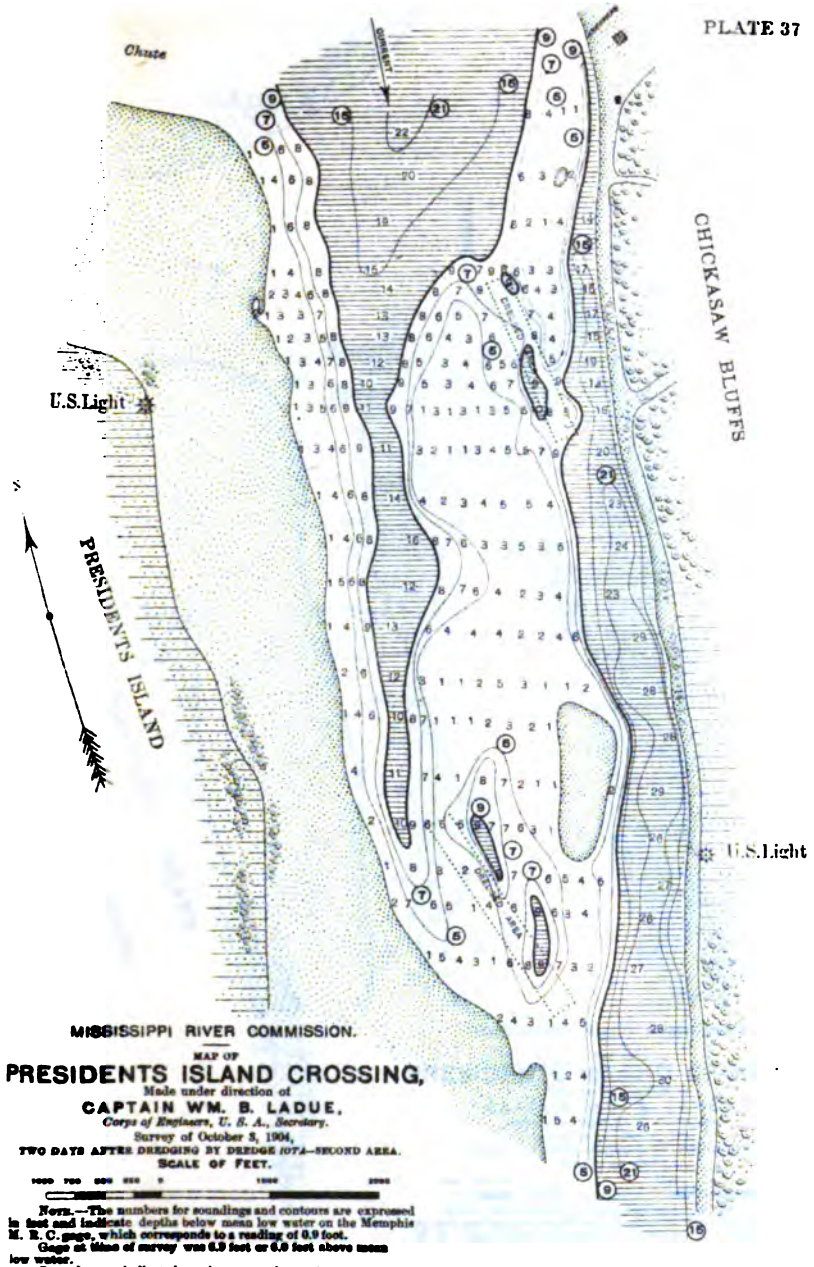
PLATE 37



MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 3, 1904,

TWO DAYS AFTER DREDGING BY DREDGE *IOTA*—SECOND AREA.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 foot.

Gage at time of survey was 6.9 feet or 6.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

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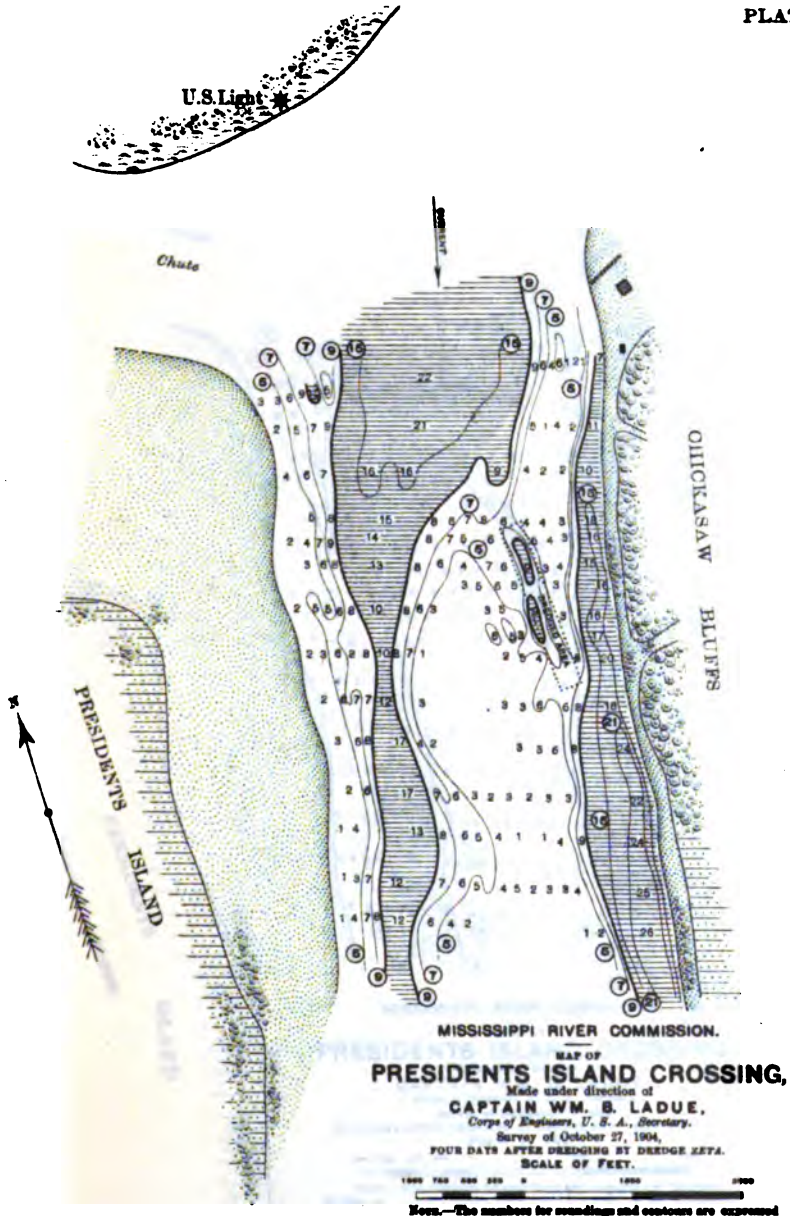

MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. S. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 27, 1904,

FOUR DAYS AFTER DREDGING BY DREDGE KETA.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 feet.

Gage at time of survey was 5.0 feet or 2.1 feet above mean low water.

Dotted areas indicate bars above mean low water.

ROBERT S. GERAHAN CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

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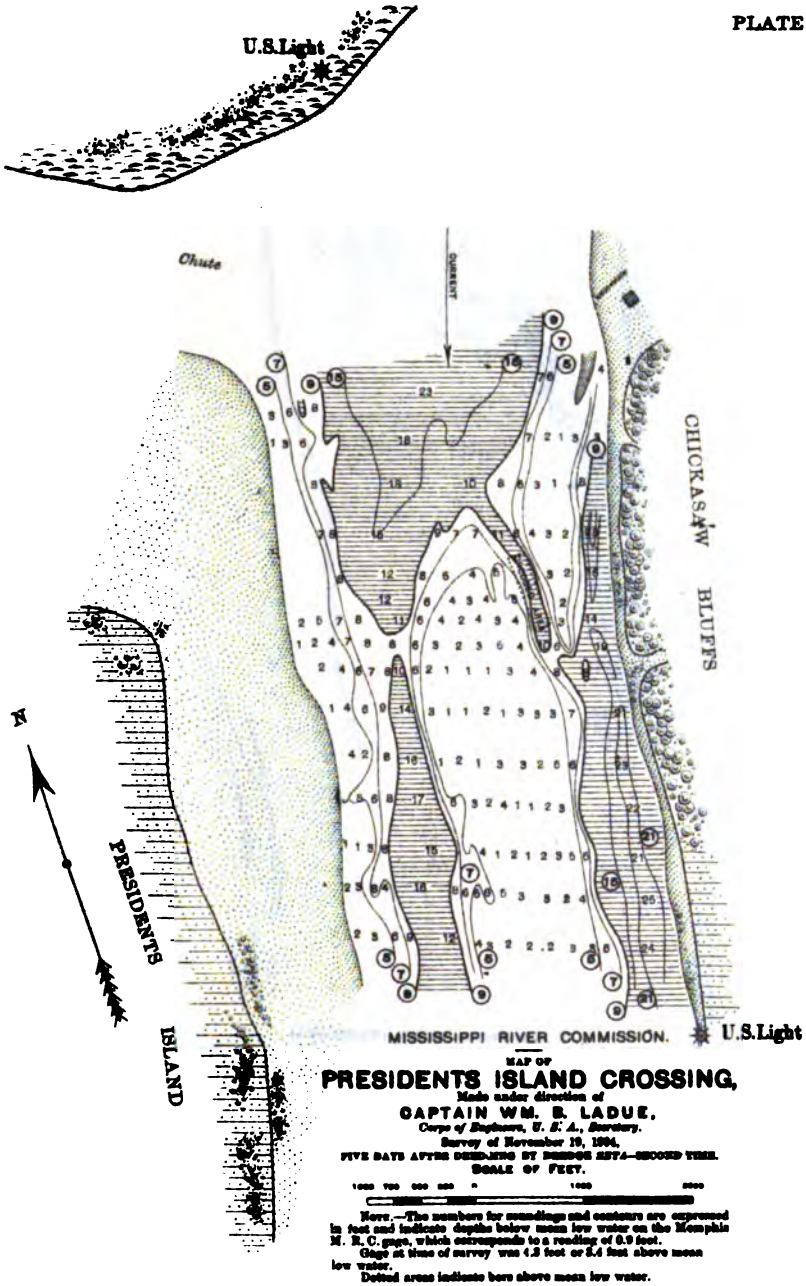

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 19, 1894,

FIVE DAYS AFTER DREDGING BY DREDGE ZETA—SECOND TIME.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 feet.

Gage at time of survey was 4.3 feet or 3.4 feet above mean low water.

Dotted areas indicate bars above mean low water.

ANDREW B. GRAHAM CO. PHOTO-LITHOGRAPHERS. WASHINGTON, D. C.

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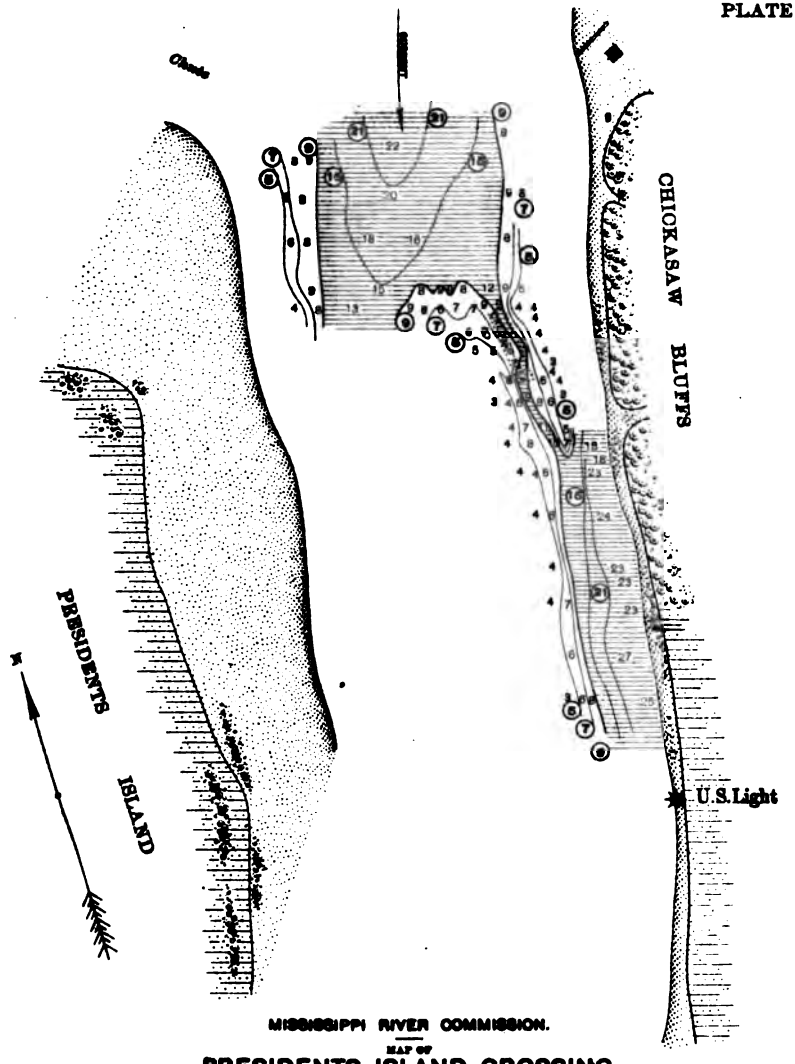

MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of December 5, 1894,

SOUNDINGS BY DEPTH ECHO—SECOND TIME.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.0 foot.

Gage at time of survey was 1.9 feet or 1.0 foot above mean low water.

Dotted areas indicate bars above mean low water.

ANDREW H. GERMAN CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

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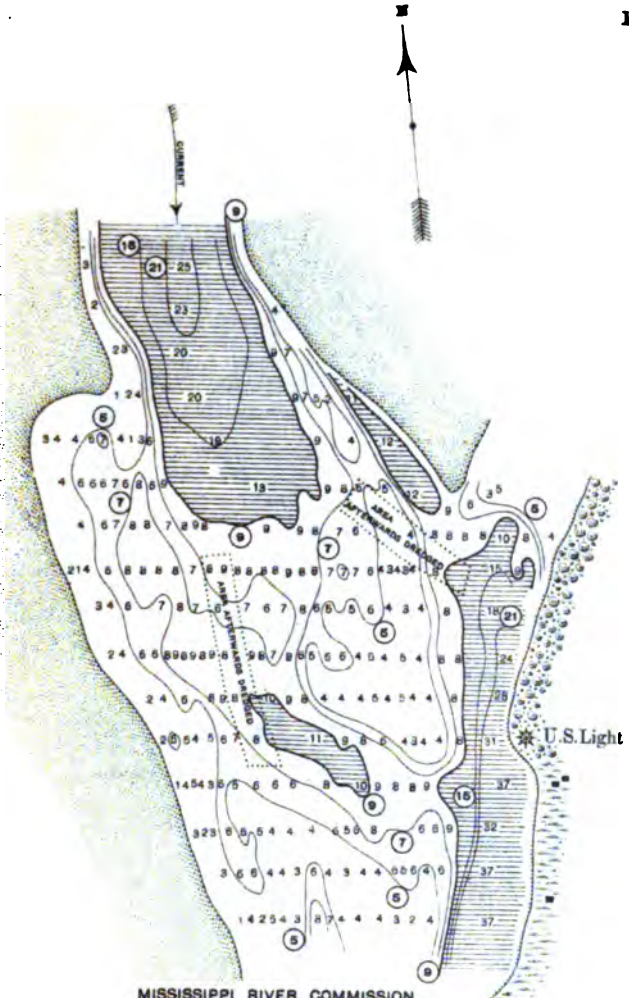

MISSISSIPPI RIVER COMMISSION.

MAP OF

FLEECES CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 17, 1904,

3 AND 12 DAYS BEFORE DREDGING BY DREDGE *1074*.

SCALE OF FEET.

1000 500 000 000 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 foot.

Gage at time of survey was 4.4 feet or 3.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

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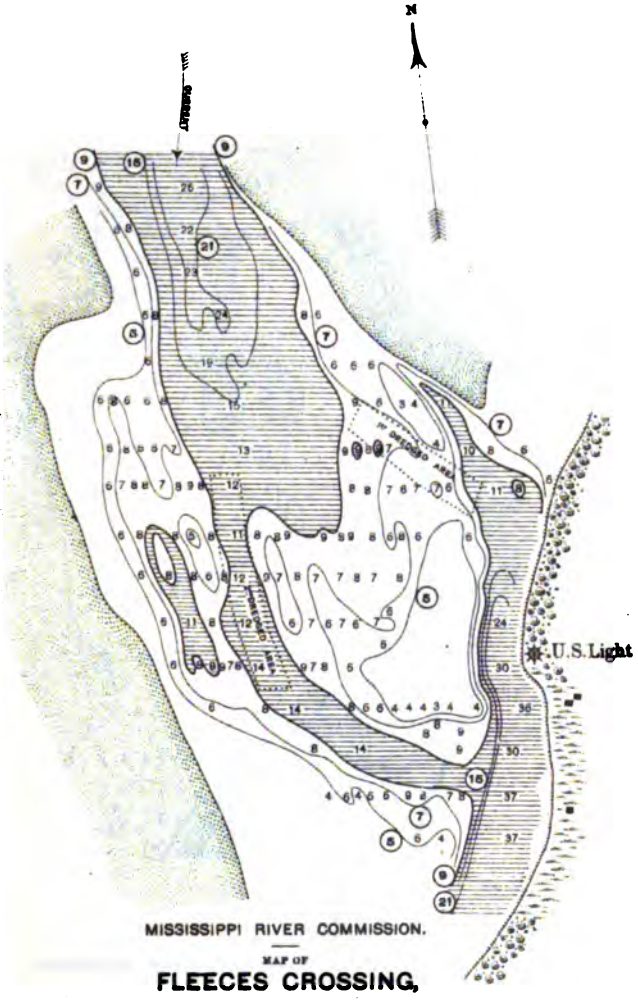

MISSISSIPPI RIVER COMMISSION.

MAP OF

FLEECES CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of December 7, 1904,

8 AND 14 DAYS AFTER DREDGING BY DREDGE *NOTA*.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.0 foot.

Gage at time of survey was 1.9 feet or 1.0 foot above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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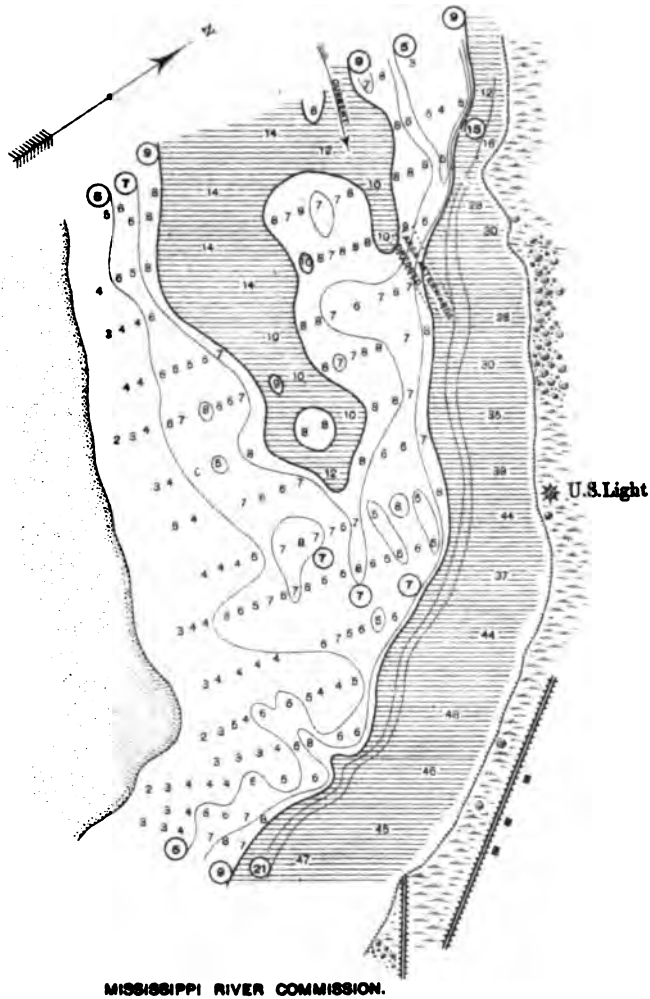

MISSISSIPPI RIVER COMMISSION.

MAP OF

POLKS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of September 18-20, 1904,

THREE DAYS BEFORE DREDGING BY DREDGE *KAPPA*.

SCALE OF FEET.

1000 500 000 000 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.0 feet.

Gage at time of survey was 3.9 feet or 5.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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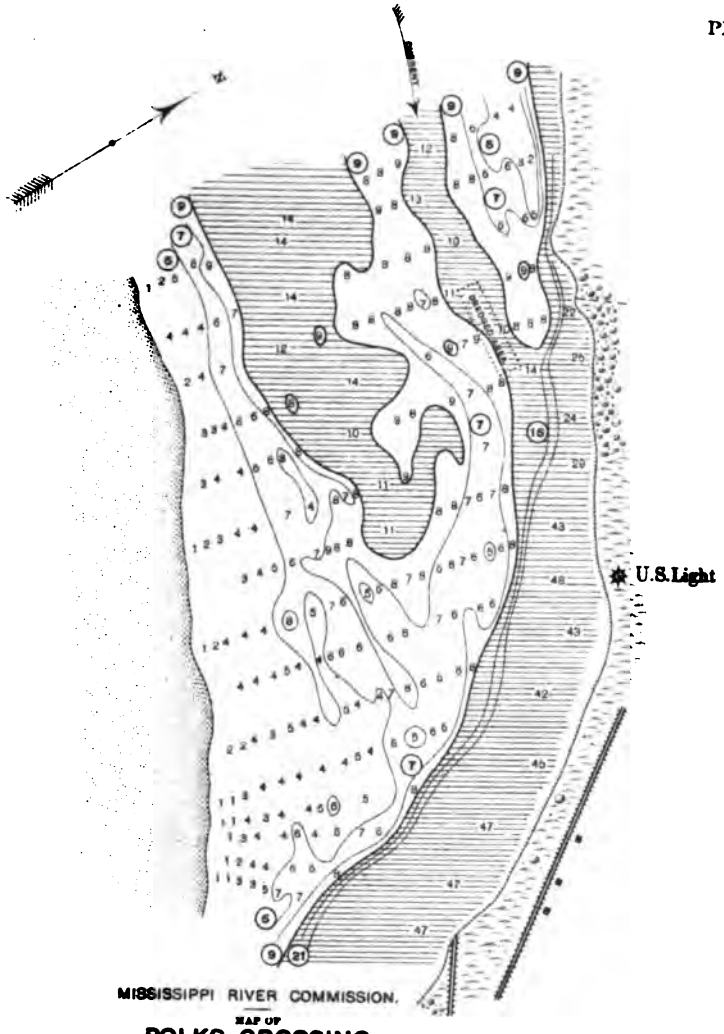

MISSISSIPPI RIVER COMMISSION.

MAP OF

POLKS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 10, 1904,

14 DAYS AFTER DREDGING BY DREDGE *KAPPA*.

SCALE OF FEET.

1000 700 500 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 foot.

Gage at time of survey was 5.9 feet or 5.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

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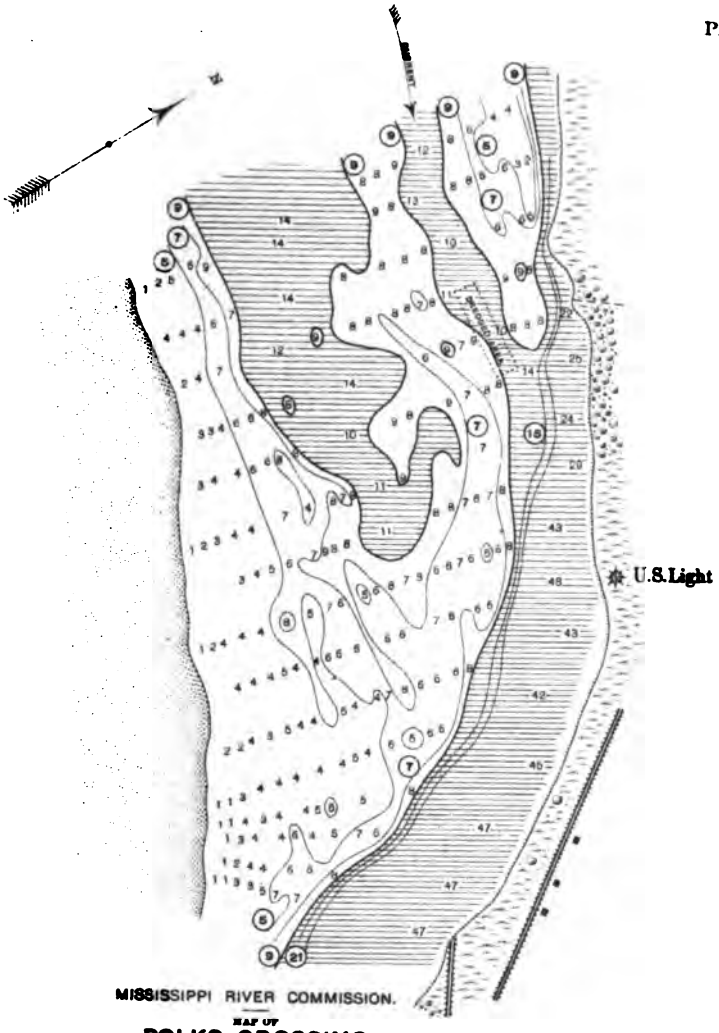

MISSISSIPPI RIVER COMMISSION.

MAP OF

POLKS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 10, 1904,

14 DAYS AFTER DREDGING BY DREDGE *KAPPA*.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 foot.

Gage at time of survey was 5.9 feet or 5.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

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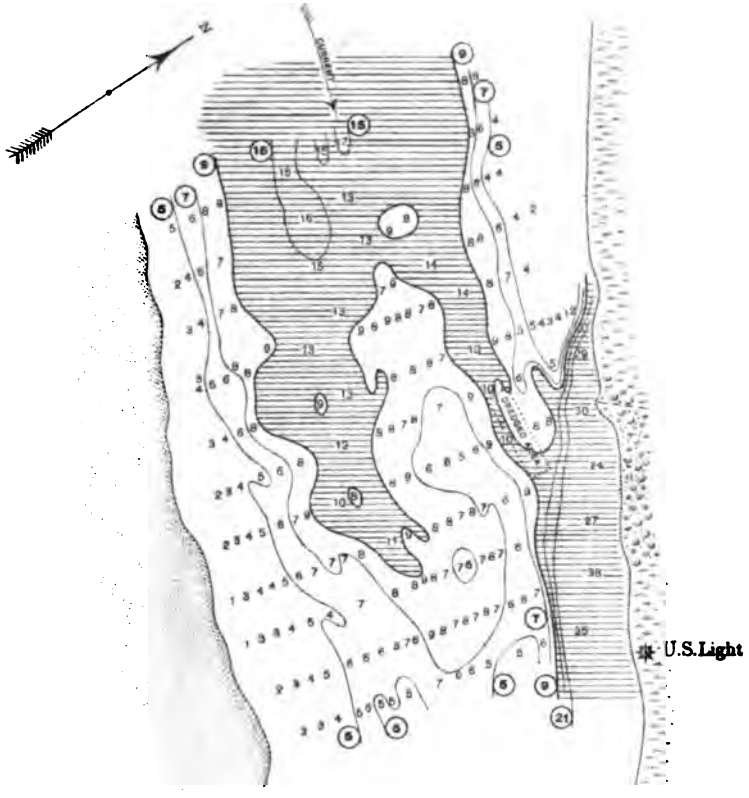

MISSISSIPPI RIVER COMMISSION.

MAP OF

POLKS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 7, 1904,

JUST BEFORE DREDGING BY DREDGE *NOTA.*

SCALE OF FEET.

1000 700 000 200 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 feet.

Gage at time of survey was 5.1 feet or 4.9 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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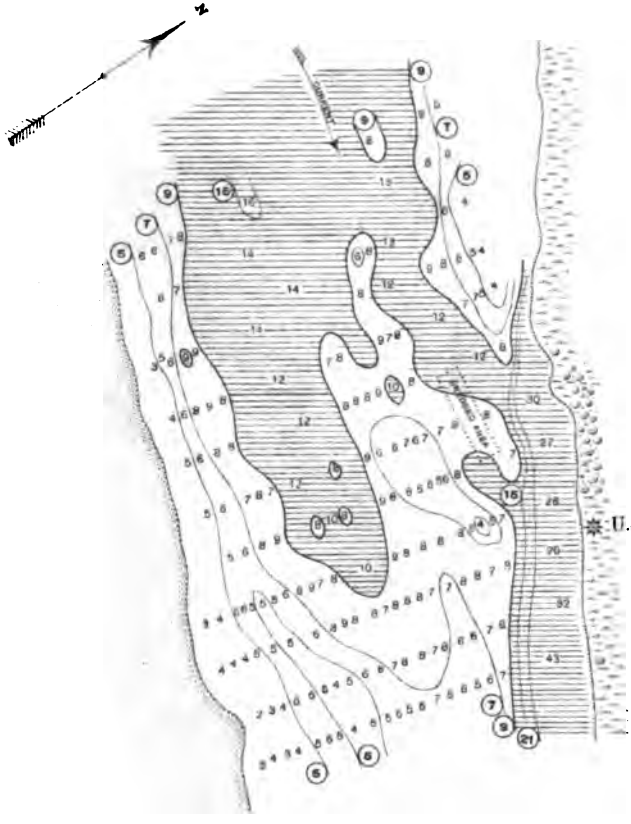

MISSISSIPPI RIVER COMMISSION.

MAP OF

POLKS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 29, 1904,

21 DAYS AFTER DREDGING BY DREDGE 107A.

SCALE OF FEET.

1000 500 000 200 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis M. R. C. gage, which corresponds to a reading of 0.9 foot.

Gage at time of survey was 2.6 feet or 1.7 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

ANDREW J. GRAHAM CO. PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

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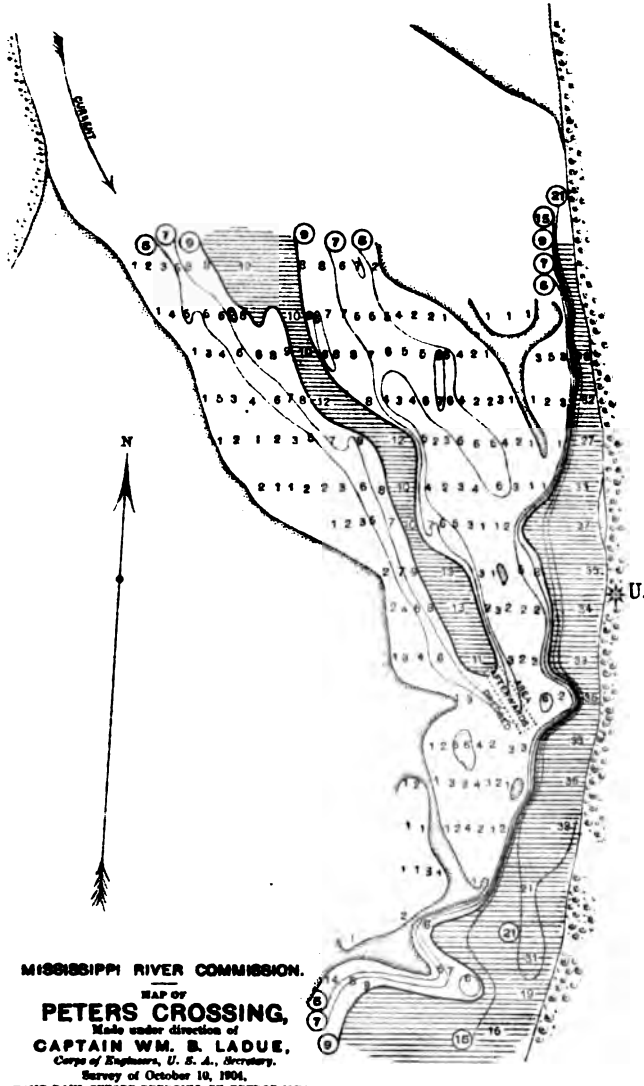
PETERS T. H.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PETERS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 10, 1904.

FOUR DAYS BEFORE DREDGING BY DREDGE 1074.

SCALE OF FEET.

000 500 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Rhoon M. R. C. gage, which corresponds to a reading of —4.0 feet.

Gage at time of survey was 3.4 feet or 7.4 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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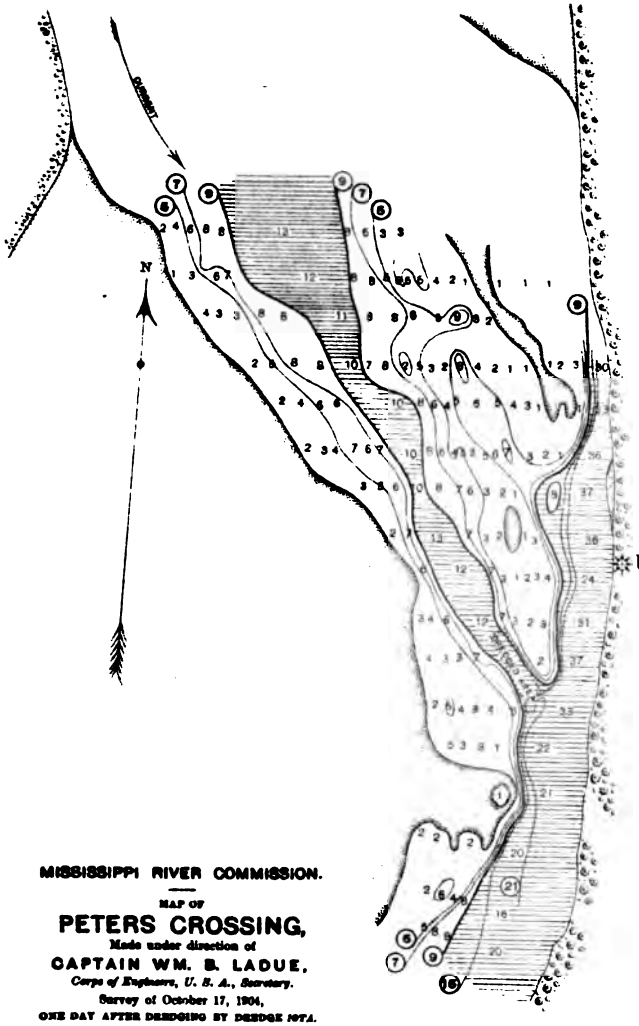
PETERS T. H.



MISSISSIPPI RIVER COMMISSION.

MAP OF

PETERS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 17, 1904,

ONE DAY AFTER DREDGING BY DREDGE *NOTA.*

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Rhoon M. R. C. gage, which corresponds to a reading of —4.6 feet.

Gage at time of survey was 1.1 feet or 5.1 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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PETERS T. H.

MISSISSIPPI RIVER COMMISSION.

MAP OF

PETERS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 17, 1904,

ONE DAY AFTER DREDGING BY DREDGE NOTA.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Mhoon M. R. C. gage, which corresponds to a reading of —4.0 feet.

Gage at time of survey was 1.1 feet or 5.1 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 59 1

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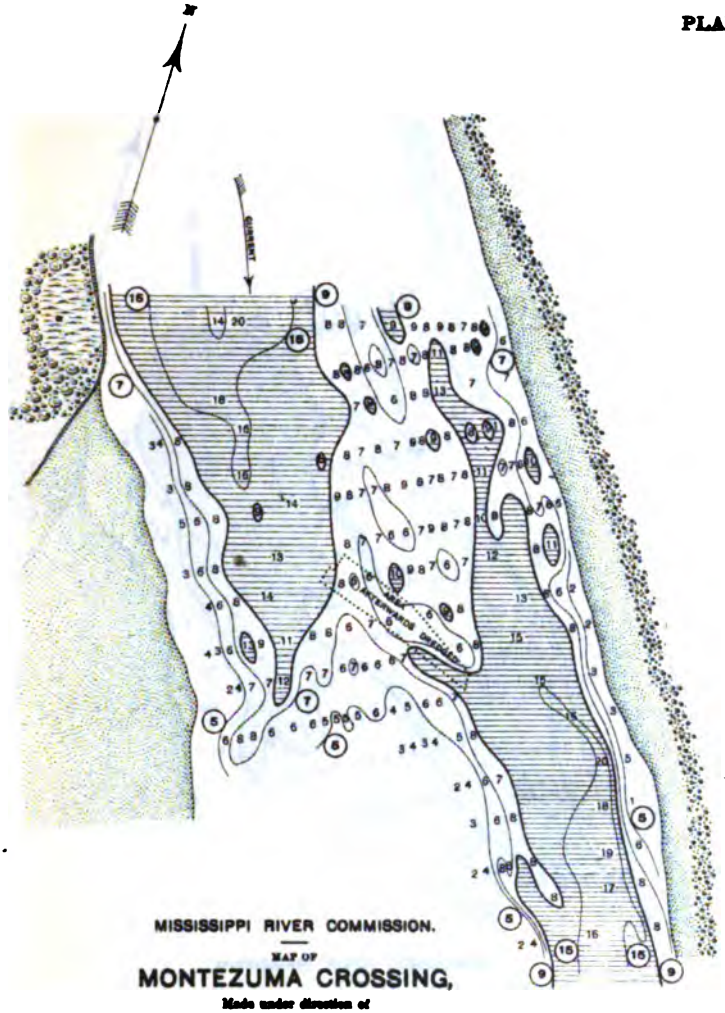

MISSISSIPPI RIVER COMMISSION.

MAP OF

MONTEZUMA CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 22, 1904,

7 DAYS BEFORE DREDGING BY DREDGE *SOTA*.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

Note.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Helena M. R. C. gage, which corresponds to a reading of 1.5 feet.

Gage at time of survey was 5.7 feet or 3.9 feet above mean low water.

Dotted zones indicate bars above mean low water.

JUDGE & GIBBONS CO PHOTO-LITHOGRAPHERS, WASHINGTON D. C.

Eng 59 1

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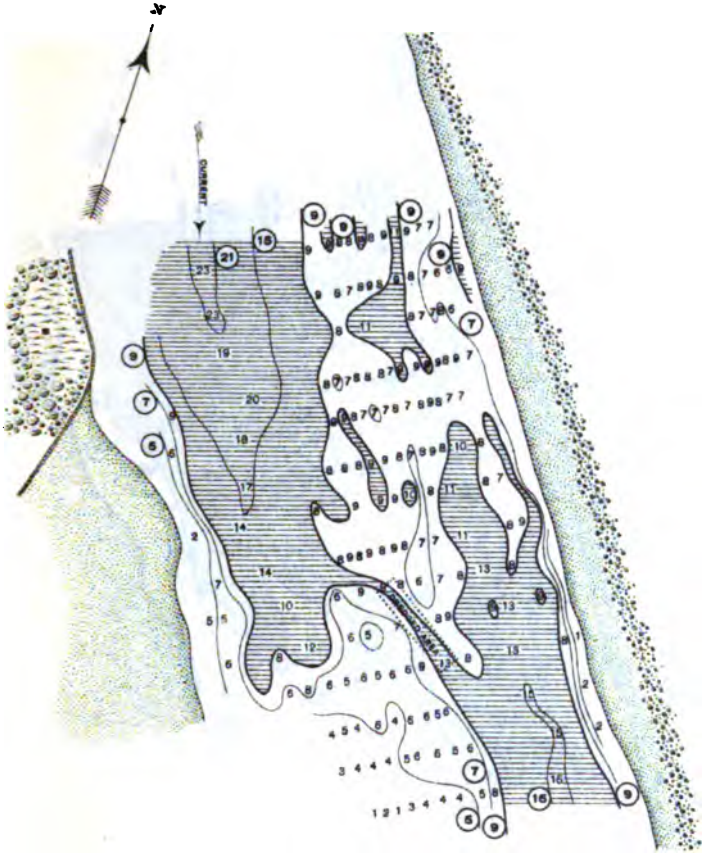

MISSISSIPPI RIVER COMMISSION.

MAP OF

MONTEZUMA CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 12, 1904,

12 DAYS AFTER DREDGING BY DREDGE *NOTA*.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Helena M. R. C. gage, which corresponds to a reading of 1.6 feet.

Gage at time of survey was 6.7 feet or 4.9 feet above mean low water.

Dotted areas indicate bars above mean low water.

HOBERT S GRAHAM CO PHOTO-LITHOGRAPHERS WASHINGTON D C

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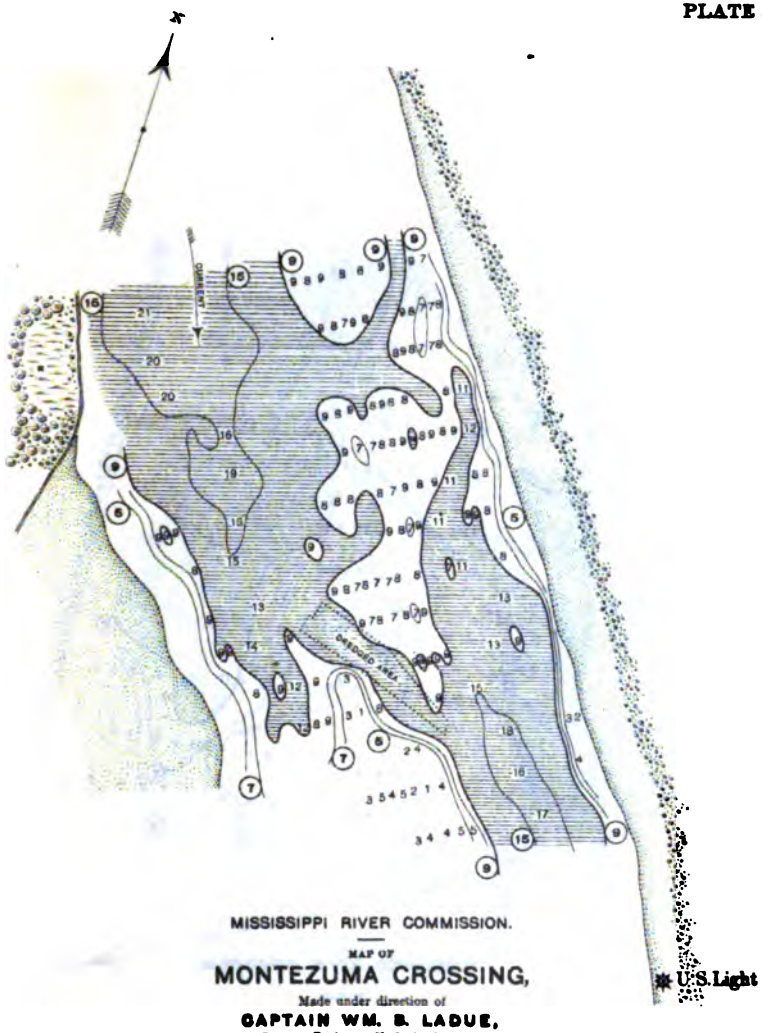

MISSISSIPPI RIVER COMMISSION.

MAP OF

MONTEZUMA CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 26, 1904,

1 DAY AFTER DREDGING BY DREDGE *KAPPA*.

SCALE OF FEET.

1000 500 000 000 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Helena M. R. C. gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 5.2 feet or 3.4 feet above mean low water.

Dotted areas indicate bars above mean low water.

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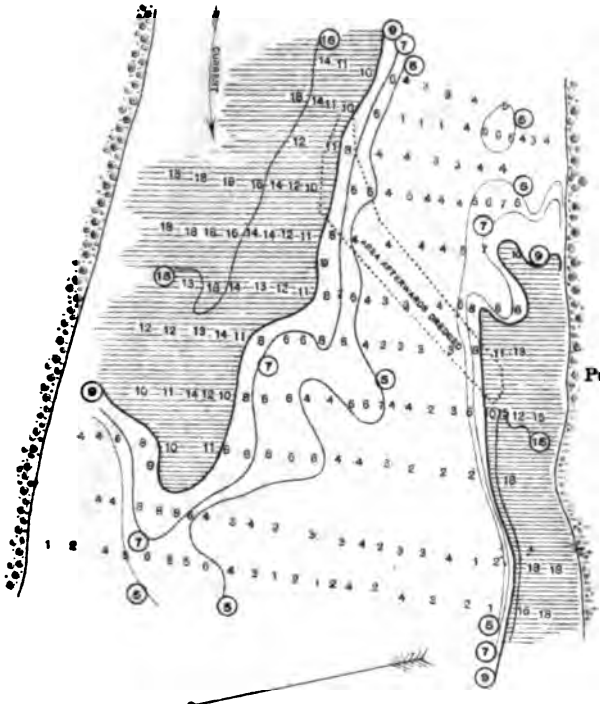

MISSISSIPPI RIVER COMMISSION.

MAP OF

ANDERSONS CROSSING,

Made under direction of

CAPTAIN WM. H. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of October 8, 1904,

TWO DAYS BEFORE DREDGING BY DREDGE *KAPPA.*

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Sunflower Landing M. R. C. gage, which corresponds to a reading of 8.1 feet.

Gage at time of survey was 11.6 feet or 3.5 feet above mean low water.

Dotted areas indicate bars above mean low water.

GEORGE CO PHOTO-LITHOGRAPHERS, WASHINGTON D C.

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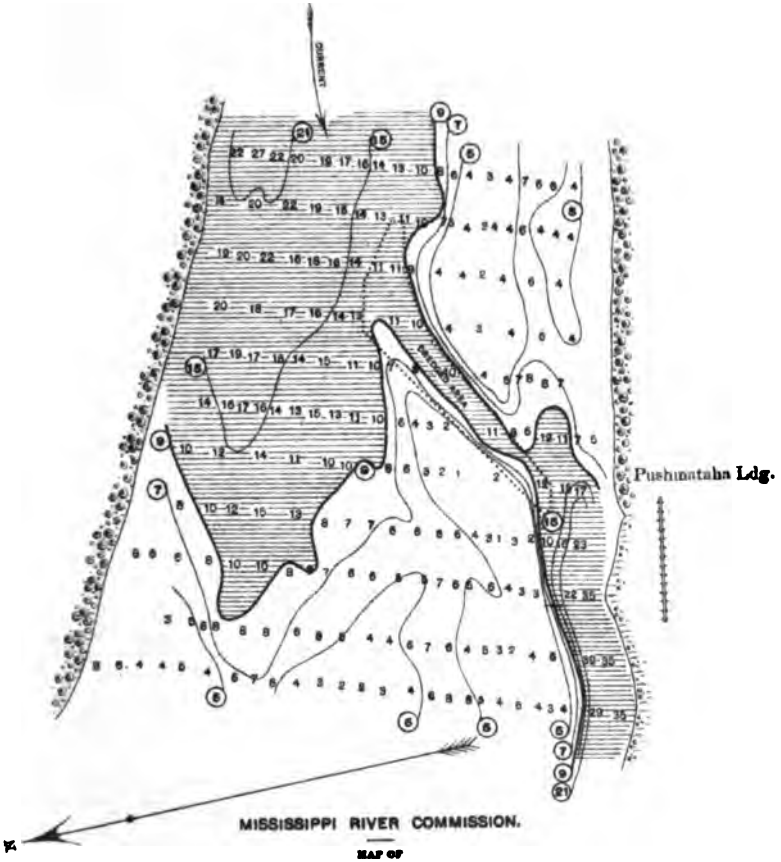

MISSISSIPPI RIVER COMMISSION.

MAP OF

ANDERSONS CROSSING,

Made under direction of

CAPTAIN WM. B. LADUE,

Corps of Engineers, U. S. A., Secretary.

Survey of November 3, 1904,

WITH DATA AFTER DREDGING BY DREDGE KAPPA.

SCALE OF FEET.

1000 700 400 200 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Sandsover Landing M. R. C. gage, which corresponds to a reading of 3.1 feet.

Gage at time of survey was 7.1 feet or 4.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

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APPENDIX 2.

REPORT OF CAPT. E. W. VAN C. LUCAS, CORPS OF ENGINEERS, ON OPERATIONS IN THE FIRST AND SECOND DISTRICTS.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., June 1, 1905.

COLONEL: I have the honor to submit the following report of operations in the first and second districts, Mississippi River improvement, for the year ending May 31, 1905.

The first district extends from Cairo, Ill., to the foot of Island No. 40, a distance of 220 miles. Operations in this district include bank revetment work at Columbus and Hickman, Ky., and at New Madrid and Caruthersville, Mo.; systematic improvement of Plum Point reach, Tennessee and Arkansas; abattis dike work; upper St. Francis and Reelfoot levee districts, and lower St. Francis levee district to the one hundred and thirty-ninth milepost.

The second district extends from the foot of Island 40 to the mouth of White River (393 R.), a distance of 173 miles, excepting on the left bank, where it ends at the Coahoma-Bolivar County line (365 L.). Operations in this district include bank revetment work at Memphis, Tenn., and Hopefield Bend and Helena, Ark.; the improvement of Wolf River, Tennessee; the White River and upper Yazoo levee districts, and the lower part of the lower St. Francis levee district.

PART I.—CHANNEL WORK.

FIRST DISTRICT (CAIRO TO FOOT OF ISLAND 40, 220 MILES).

Columbus, Ky. (*21 L.*).—(For description and previous history, see p. 3580. Report of Chief of Engineers, 1891.) Special appropriation. This work (see map No. 1, herewith) consists of a series of five spur dikes protecting about 2,200 feet of bank in front of the town. No work has been done since 1890, and the present conditions are fairly good and as stated in the last annual report.

Hickman, Ky. (*36 L.*)—For description and previous history, see Reports of Chief of Engineers, 1890, p. 3197; 1895, p. 3756; 1902, Supplement, p. 91.) Special appropriation. This revetment (see map No. 2, herewith) was placed in 1889, 1892, and 1894, and includes 1,450 feet of effective revetment, of which 800 feet is old style woven mattress and 650 feet, fascine mattress. The work is in satisfactory condition.

New Madrid, Mo. (*71 R.*).—(For description and previous history, see Reports of Chief of Engineers, 1894, p. 2859; 1895, p. 3757; 1897, p. 3696; 1899, p. 3504; 1900, p. 4784.) Special appropriation. This work (see map No. 3, herewith) consists of 4,450 feet of effective revetment, all of fascine mattress, and is generally in good condition, excepting at a few places near the low-water line, where the brush is somewhat decayed. This will be repaired whenever the stage of water is sufficiently low.

The channel crossing just above the town, mentioned in last annual report, appears to be working downstream, and the extension upstream may not be necessary, although still a possibility.

Caruthersville, Mo. (*110 R.*).—(For description and previous history, see Reports of Chief of Engineers, 1899, p. 3504; 1900, p. 4384, and 1903, Supplement, p. 169.) Special appropriation. This work (see map No. 4, herewith) consists of one dike and about 2,300 feet of effective revetment, all of fascine mattress. This revetment is in good condition, and the bank immediately above and below has continued as stated in the last annual report.

PLUM POINT REACH (147 TO 186 MILES BELOW CAIRO.)

[See map No. 5, herewith.]

The works of improvement in this reach extend from above Daniels Point to near Craighead Point, Arkansas, a distance of about 20 miles (151–171). These operations were begun in 1882 and have been fully described in subsequent reports. In general terms, the work done has been the closure of Osceola and Bullerton chutes by pile dikes, the partial closure of Gold Dust Chute by pile and a brush-and-stone dam, the contraction of the low-water channel by

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dikes at Ashport bar, Elmot bar, and Plum Point; the revetment of caving banks above Daniels Point, throughout Ashport and Fletchers bends, along a part of the fronts of Osceola and Bullerton bars, at Plum Point and near Craighead Point; and the construction of levees along both banks of the river.

Details of work are as follows:

Daniels Point, Arkansas (152 R.).—(For description and previous history see Report of Chief of Engineers, 1903, Supplement, p. 170.) (See map No. 6, herewith.) Until recently this revetment extended about 8,800 feet upstream from Daniels Point, but during the past two years the lower 4,000 feet has been practically destroyed, only a few detached pieces of revetment remaining.

During the past year minor work, at a cost of $575.55, was done at this place. (For details see report of Assistant Engineer A. J. Nolty, Appendix 2 A, herewith.)

At present the effective continuous revetment is 5,600 feet long, of which the upper 4,800 feet is of fascine mattresses and the lower 800 feet of dikes and small fascine mattresses combined. About 2,000 feet below are some small detached fascine mattresses.

The caving below the upper work appears to have ceased, and there is no apparent necessity for replacing it. No operations are contemplated for the coming season.

Ashport Bend, Tennessee (155 L.).—(For description and previous history see Reports of Chief of Engineers, 1900, p. 4785; 1903, Supplement, p. 170.) This bend (see map No. 7, herewith) has a continuous revetment about 16,450 feet long, of which about 7,500 feet at the lower end is of fascine mattresses and the remainder of woven mattresses. It is all in effective condition.

No work was necessary during the past season. The willows planted the previous season have not yet grown sufficiently to indicate their value.

Fletchers Bend, Arkansas (158–161 R.).—(For description and previous history see Reports of Chief of Engineers, 1900, p. 4786; 1903, Supplement, p. 170; 1904, Supplement, p. 134.) This revetment (see map No. 8, herewith) had an effective length of 14,900 feet at the beginning of the year, of which 7,550 feet consisted of groynes, dikes, and woven mattresses and 7,400 feet of fascine mattresses. During the past year the gap below the 1903 work was closed with 2,300 feet of fascine mattress work, and, in addition, the lower part of the 1891 woven mattress was reinforced with fascine mattress for a distance of 662 feet. The present effective length of this revetment is 17,132 feet, of which 10,294 feet are of fascine mattress and the remainder of the old woven-mattress type.

The supply of stone for this work was purchased in open market before the beginning of the working season, from quarries in the Ohio and Upper Mississippi rivers, and towed to Fletchers Bend with Government plant. This method was found to be economical, insured a certain supply, and was generally satisfactory. It should, however, be commenced as soon as possible after the subsidence of the spring rise, in order to insure at each locality an ample supply before the working season begins.

No difficulty was experienced in obtaining labor and the year's work was generally satisfactory. (For details see report of Assistant Engineer A. J. Nolty, Appendix 2 A, herewith.)

Middle and Lower Osceola bar (163 R.).—(For description and previous history see Reports of Chief of Engineers, 1896, p. 3600; 1903, Supplement, p. 170; and 1904, Supplement, p. 134.) This revetment (see map No. 9, herewith) has a present effective length of about 4,300 feet, of which all but 300 feet at the head is of woven mattress. Its condition is about as stated in last annual report, the channel having divided just above the head of this revetment, and the current attack having materially lessened.

No work was done here during the past year, and none is contemplated for the coming season.

Lower Osceola and Bullerton bars, Arkansas (165–168 R.).—The revetment at this place (see map No. 10 herewith), 14,300 feet long, is all effective and consists of 1,400 feet of woven mattress revetment, and 11,200 feet of fascine mattress revetment. The fascine mattress in this revetment is notable as being the first extensive fascine work done on the Mississippi River. It was placed in 1893–94, is in excellent condition, and until this last year had cost nothing for maintenance or repairs.

During the past year repair work, at a cost of $484.45, was done at this locality, and consisted of repairing a small section of bank above from which the stone had been cut away, probably during the run of ice during the previous winter.

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Abattis dikes.—No allotment was made for the construction of abattis dikes during the past season, but all dikes in place at the beginning of the year have continued to accumulate deposit. In my judgment, the experience with this type of dike has indicated its marked value when properly placed, and I think it could be most advantageously used at various places whenever funds are available. This is notably the case in Gold Dust Chute, which, during the past few years, has been gradually enlarging.

SECOND DISTRICT (FOOT OF ISLAND 40 TO WHITE RIVER, 173 MILES).

Hopefield Bend, Arkansas (227–230 R.).—(For description and previous history see Reports of Chief of Engineers, 1900, p. 4787; 1903, Supplement, p. 172; 1904, Supplement, p. 135.) The revetment at this place (see maps Nos. 11 and 13 herewith), originally extending a distance of 16,600 feet from Mound City Chute to Hopefield Point, is essential to the maintenance of deep water in Memphis Harbor. From station 0 upstream to Mound City Chute, a distance of 6,300 feet, the original revetment was of light woven mattresses built in 1883–1885, and has been destroyed and replaced during the last two working seasons with new fascine mattress revetment from station 0 to station 39 W, and it is hoped that further extension upstream will be unnecessary. From station 0 downstream, a distance of 4,000 feet, the revetment was of diagonal woven mattresses built between 1887 and 1892, a great part of which has been reenforced or replaced with fascine mattress work. Below this the revetment consists of 6,300 feet of fascine mattresses, which, when the bank was last exposed, was in good condition.

Work during the past year was carried on with an allotment of $120,000 from the appropriation of June 13, 1904, and consisted of about 1,600 feet of new fascine mattress revetment, closing the gap immediately above station 0, and in addition about 2,300 feet of reenforcing mattress along the weakest parts of the 4,000 feet of woven mattress immediately below station 0. In addition, there were placed 16 connecting mats, made necessary by the irregular shape of the bank. The season's project contemplated the complete reenforcement from station 0 to station 40 E, but on account of the breaking up of much of the old revetment immediately below station 0 much repaving was necessary, and the allotment was insufficient to complete the reenforcing work, a gap of about 1,000 feet being left between stations 19 E and 29 E, which should be reenforced during the coming season. The present effective revetment is about 14,200 feet long, all in good condition excepting the 1,000 feet between stations 19 E and 29 E, above noted. Between stations 0 and 39 W the bank paving should be carried to the top of the bank as soon as funds will permit.

The work of the season was carried on without special incident, excepting that on account of the shortage of labor the deliveries of brush were not as rapid as desirable. Stone deliveries were also much delayed because the contractor could not get his barges away from the quarry on account of the unusually low stage of the Ohio River. Some emergency purchases of stone were made and the excess cost charged to the contractor.

These delays in the delivery of brush and stone retarded the completion of work until late in the season, and operations had to be suspended between January 15 and 20 and between January 25 and February 20 on account of heavy runs of ice. (For further details see report of Assistant Engineer W. M. Rees, Appendix 2 B, herewith.)

Wolf River, Tennessee (230 L.).—(For description and previous history see Reports of Chief of Engineers, 1893, p. 2136; 1895, p. 1703; 1902, Supplement, p. 93; 1903, Supplement, p. 172; 1904, Supplement, p. 136.) Special appropriation. The object of this improvement is the maintenance by dredging of the navigable channel to the county bridge 2½ miles above the river mouth, the work being done with Government plant and hired labor.

Work done during the year was carried on under an allotment of $8,000 from the emergency river and harbor act of April 28, 1904. Operations were carried on between August 18 and December 31, and resulted in the removal of 47,440 cubic yards of earth, at a cost of 11.15 cents per cubic yard; 340 cubic yards of rock, at $1.06 per cubic yard; and 166 obstructions, at $2.95.

After the completion of the season's work there remained a sufficient balance available for completely repairing the plant belonging to this work. (For further details see report of Assistant Engineer W. M. Rees, Appendix 2 B, herewith.)

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The usual dredging operations will be carried on during the coming season.

Memphis Harbor, Tennessee (230–232 L.).—(For description and previous history see reports of the Mississippi River Commission since 1882). The work at this place (see maps Nos. 13 and 14 herewith) is the protection of between 2 and 3 miles of the city front. A total of 14,800 feet of protection work has been constructed, of which the upper part is now covered by a sand bar. This silted up revetment is of woven mattresses and would probably be destroyed if subjected to current attack. The present effective revetment is 9,900 feet in length, and includes 4,100 feet of woven mattress revetment, 2,100 feet of dike work, and 3,700 feet of fascine mattress work. The sand bar covering the upper part of the city front has, during the last two years, increased in height an average of about 2.6 feet between the 10 and 29 foot stages. The area of the bar has decreased in the past two years, due to caving at the lower end, which has ceased, and a tendency to increase in area at the upper end is apparent.

The condition of the revetment work is generally good. No work was necessary during the past year and none is contemplated for the coming season.

Helena, Ark. (306 R.).—(For description and previous history see Reports of Chief of Engineers, 1890, p. 3212; 1897, p. 3701; 1899, p. 3508; 1900, p. 4789; 1903, Supplement, p. 173; 1904, Supplement, p. 136.) Special appropriation. The work at this place (see maps Nos. 16 and 17 herewith) consists of 4,900 feet of bank revetment, of which 1,400 feet is dike work, 500 feet woven mattress work, and 3,050 feet fascine mattress work. Where mattresses have been used the revetment work is generally in good condition, but along the bank protected by dikes sloughing has taken place to a serious extent.

Some further sloughing has occurred back of both dike and mattress revetment work, but the levee is still intact. The result of examinations made during the last year indicates that the trouble is caused by a stratum of quicksand so far below the surface that it can not be intercepted or held in position. In all probability the sloughing will continue until the levee is involved, and to meet such an emergency there was constructed during the past year a cross levee below the involved bank connecting the main White River levee with the high ground west of the river. The local board at Helena contemplates a similar cross levee just above the sloughing bank, and the owners of the land behind the threatened levee prefer to take their chances of maintaining the old levee rather than give up the valuable land which would be necessary for the construction of a loop.

No revetment work was done here during the past year and none is contemplated for the coming season, although there is an available balance of about $10,000 to the credit of this work.

PLANT.

During the year repair work on plant was continued with the unexpended balance from the previous year, an allotment from the appropriation of April 28, 1904, and the proceeds from sales of condemned property.

No new work was done, the principal work aside from the care and maintenance of plant being the continuation of reconstruction of deteriorated plant which had been in progress during the two previous years, seven barges having been rebuilt during the season. During the year three barges were cut down by floating ice and lost, and four barges were condemned as unserviceable, and there remain five unserviceable barges awaiting condemnation.

After the completion of repair and reconstruction work there was sufficient plant on hand for the two construction parties placed in the field last fall, with the exception of a deficiency in barges, which was partially made up by the loan of four barges from the third district.

The small propeller steamer *Unique* purchased last year has rendered effective service and is of material value for inspection and survey work. It has been found generally satisfactory with the exception of the engine, which is, perhaps, too light for the 200 horsepower developed.

With the allotment of $50,000 from the appropriation of March 3, 1905, there will be constructed a derrick boat for handling stone between bank and barges, three material barges, and two mattress barges, and the balance of the allotment will be utilized in general repair work and the care of plant during the ensuing year. (For further details see report of Assistant Engineer A. J. Nolty, Appendix 2 C herewith.)

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STONE.

For revetment work in the first and second districts stone is purchased from allotments to the various works, there being no separate stone allotment as in the third district. As for years past the amount of work needed at the various revetments has been far in excess of that possible with available funds, each working season has found the allotments for channel work nearly exhausted, and it has, in consequence, been impossible to provide in advance of the working season an adequate supply of stone. This has resulted in delayed deliveries and consequent increased cost.

I strongly recommend that in future there be allotted for the first and second districts an amount for stone sufficient to insure a full supply for the operations of the next year.

GENERAL REMARKS ON CHANNEL WORK.

For the first time in several years the reconstruction work with fascine mattresses in the first and second districts has progressed faster than the old woven mattresses have been destroyed, and both at Fletchers Bend and Hopefield Bend the gaps in the revetment have been closed and considerable reenforcement work over the old woven mattresses has been placed. With the allotments for the next fiscal year it should be possible to place the Hopefield Bend revetment in thoroughly good condition and materially improve Fletchers Bend revetment.

My experience of three seasons in the first, second, and third districts has strongly impressed me with the value of the form of close-pitched hand-laid paving underlaid with spalls, in use in the first and second districts, which, in my judgment, is superior to any form of bank paving used on work under the Commission. Repairs to bank paving of this description are of rare occurrence, and usually necessary only when paving has been injured by floating ice.

PART II.—LEVEE WORK.

Upper St. Francis levee district (0–70 R.).—(For description and previous history see Report of Chief of Engineers, 1903, Supplement, p. 74; 1904, Supplement, p. 140.) (See map No. 21 herewith.) This district properly begins at Commerce, Mo., but only the part south of Cairo is under the Commission's jurisdiction. The local levee board has petitioned to have the Commission's jurisdiction extended to the head of the territory subject to overflow, and the Commission has so recommended, but Congress has not as yet taken the necessary action. When completed the levee below Cairo will be about 54 miles long and will protect about 700 square miles.

To the end of last year about 6 miles of levee had been built south of Cairo with the exception of 8,259 cubic yards of unfinished work completed last August. During the year, with the allotments of $15,000 from the 1904–5 appropriation and of $25,000 from the 1905–6 appropriation, levee was constructed from stations 9/8 to 10/23 and from stations 10/28 to 15/38, containing a total of 290,207 cubic yards. In addition the local board constructed levee from stations 8/16 to 9/8, 15/38 to 16/10, 16/23 to 18/44, 25/44 to 26/36, and 5/30 to 5/33, containing a total of 187,615 cubic yards. The local landowners also added to the levee between stations 18/44 and 25/44 about 20,000 cubic yards.

Summary of earth in place.

	In place Apr. 30, 1904.	Added during year.	In place Apr. 30, 1905.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
By United States	377,198	299,166.6	676,364.6
By levee board and others	283,804	207,614.6	491,418.6
Total	661,002	506,781.2	1,167,783.2

Nothing was lost or abandoned on account of caving banks or other causes.

At the beginning of the year the Brewer Lake culvert, described in last year's report, had been completed with the exception of some minor details, the work having been delayed on account of the overflow of last spring. The culvert was completed early in the season at a total cost of $8,712.38. This cost is considered high, and future construction of like character should be done at considerably less cost.

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Under an allotment of $30,000 from the appropriation of March 3, 1905, bids were opened May 25 for about 170,000 cubic yards of new work between stations 6/8 and 8/16, and the lowest bid, 14.45 cents, by the Talley-Bates Construction Company, has been recommended for acceptance. The completion of this contract will close the gap in this levee and give a continuous line for nearly 30 miles south of Cairo. The completion of the upper St. Francis levee below Cairo will require the addition of about 4,500,000 cubic yards of embankment at an estimated cost of approximately $675,000. (For further details see report of Junior Engineer D. M. Brock, Appendix 2 D herewith.)

Reelfoot levee district (36–60 L.).—(For description and previous history see Report of the Chief of Engineers, 1903, Supplement, p. 174, and map No. 21 herewith.) This levee when completed will be about 21 miles long and will protect about 310 square miles. To the end of the present year about 9½ miles have been built at the upper end and about 4 miles at the lower end.

With allotments of $15,000 from the 1904–5 appropriation and $15,000 from the 1905–6 appropriation, contracts were made during the year and the levee extended from stations 5/33 to 9/30, the new yardage aggregating 218,470 cubic yards. The gap between stations 5/25 and 5/32, made during the 1904 high water, was also repaired by the addition of 11,159.5 cubic yards.

The Lake County levee board added 50,000 cubic yards along the upper end of the levee in the way of repair work. The Fulton County levee board did no work on the levee during the season.

Summary of earth in place.

	In place Apr. 30, 1904.	Added during year.	In place Apr. 30, 1905.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
By United States	253,361	229,630	482,991
By levee board and others	535,770	50,000	585,770
Total	789,131	279,630	1,068,761

Nothing lost during year from caving banks or other causes.

The Commission made no allotment for this district from the new 1905–6 appropriation, but instead, by resolution of April 11, 1905, recommended that the officer in charge of the first district be authorized to enter into a contract for closing the gap about 7¼ miles long, now existing in this levee, amount of said contract not to exceed $100,000. This resolution has been approved by the Secretary of War with the restriction that the work can not be done in advance of the year when the funds become available. As no funds will be available for this purpose before July 1, 1906, it will hardly be advisable to enter into contract for this work before next March.

After the present year's work there will be required to complete this levee a total of about 1,250,000 cubic yards at an estimated cost of $180,000. (For further details see report of Junior Engineer D. M. Brock, Appendix 2 D, herewith.)

Lower St. Francis levee district (79–298 R.).—(For description and previous history see Report of Chief of Engineers, 1903, Supplement, p. 174, and maps Nos. 21, 22, and 23 herewith.) When completed this levee will be about 215 miles long and will protect about 3,500 square miles. Its present length is 210 miles, the gap between Cat Island and Bledsoe having been closed during the past season. At the beginning of the year there were in force one of the 1902–3 and two of the 1903–4 contracts, which have since been completed. Under the allotment of $140,000 from the 1904–5 appropriation, contracts were made as follows:

Location.	Miles below Cairo.	Cubic yards.	Price per cubic yard.	Cost.
			Cents.	
Point Pleasant	80 R.	97,155.9	13.25	$12,873.16
54/11–55/30	140 R.	137,296.5	13.75	18,878.27
65-18–69 0	151–154 R.	124,112.5	17.00	21,099.12
690-720	154–157 R.	75,561.2	17.45	13,185.43
1040–1080	191–195 R.	161,630.0	16.45	26,588.13
108/22–112/42	196 R.	79,833.3	16.5	13,172.49
1160–117/28	200 R.	135,514.0	16.45	22,292.06
1340–1390	213–218 R.	177,293.8	15.74	27,906.04

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Under the special appropriation of $90,000 of June 13, 1902, for extension and enlargement of Walnut Bend levee, contract was made as follows:

Location.	Miles below Cairo.	Cubic yards.	Price per cubic yard.	Cost.
			Cents.	
211/47–214/88	281 R.	525,508	14.90	$78,299.94

Under the allotment of $140,000 from the 1905–6 appropriation, the following contracts were made:

Location.	Miles below Cairo.	Cubic yards.	Price per cubic yard.	Cost.
			Cents.	
72/0–81/0	165–167 R.	162,278.5	13	$21,095.56
98/0–104/0	185–191 R.	169,664.0	14.20	24,092.28
139/0–150/0	217–231 R.	374,758.7	15.74	58,987.02

In addition to the above contract work considerable repair work was done, and the local levee board placed 823,059 cubic yards, completing the closure of the Cat Island gap, making a total of yardage placed during the year of 3,234,563, from which should be deducted 150,000 cubic yards abandoned. All of the contracts made by this office have been completed with the exception of that at Walnut Bend, which should be finished before the end of the present fiscal year.

Summary of earth in place.

	In place Apr. 30, 1904.	Added during year.	In place Apr. 30, 1905.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
By the United States	5,234,111	2,411,504	7,645,615
By local board	10,071,861	823,059	10,894,920
Total	15,305,972	3,234,563	18,540,535
Lost or abandoned			150,000
Total			18,390,535

Amount required to complete this levee system, about 6,000,000 cubic yards, at an estimated cost of $1,200,000.

Under the allotment of $140,000 from the appropriation of March 3, 1905, bids were opened May 25 for 634,500 cubic yards of enlargement and new work at the points along this levee where most needed, and recommendation for award has been forwarded for approval. (For further details see report of Assistant Engineer M. Gardner, Appendix 2 E, herewith.)

Upper Yazoo levee district (244–365 L.).—(For description and previous history see Report of Chief of Engineers, 1903, Supplement, p. 178, and maps Nos. 23 and 24 herewith.) This district has 124 miles of levee protecting an area of 3,281 square miles. At the beginning of the year 1903–4 one contract was still in force and was completed in November last. Under the $70,000 allotment from the 1904–5 appropriation and the $60,000 allotment from the 1905–6 appropriation, contracts were made for about 600,000 cubic yards of additional new work, as follows:

Location.	Miles below Cairo.	Cubic yards.	Price per cubic yard.	Cost.
			Cents.	
80/44–82/0	332 R.	359,695.8	17.49	$62,900.30
121/0–122/8	356 R.	241,695.8	13.74	33,207.63

All of which has been completed.

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The local board has placed during the year 1,614,614 cubic yards of new work, making a total of 2,373,250 cubic yards added during the year.

Summary of earth in place

	In place Apr. 30, 1904.	Added during year.	In place Apr. 30, 1905.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
By United States	6,617,786	758,635	7,376,421
By local board	15,432,836	1,614,615	17,047,451
Total	22,050,622	2,373,250	24,424,872

Nothing lost from caving banks or other causes during year.

To complete this levee will require the addition of about 3,250,000 cubic yards, at an estimated cost of $650,000. (For further details see Report of Assistant Engineer M. Gardner, Appendix 2 E, herewith.)

White River levee district (306 to 385 R.).—(For description and previous history, see Report of chief of Engineers, 1903, Supplement, p. 176, and map No. 24 herewith.) This levee is 74 miles long, of which 67 miles is controlled by the United States, the remaining 7 miles being private levee protecting the back of Laconia Circle, which is maintained by the Laconia levee board. When completed this levee will protect an area of 910 square miles. At the beginning of the year there were no contracts in force. With the allotment of $70,000 from the 1904–5 appropriation, contracts were made as follows:

Location.	Miles below Cairo.	Cubic yards.	Price per cubic yard.	Remarks.
			Cents.	
38/36–45/0	344–362 R.	220,000	17.40	Not completed.
47/48–48/30	368 R.	130,000	14.00	Do.

Neither of these contracts is yet completed, on account of unfavorable weather conditions. Under the same allotment about 2 miles of topping, aggregating 15,000 cubic yards, were placed. Under the $70,000 allotment from the 1905–6 appropriation contracts were made as follows:

Location.	Miles below Cairo.	Cubic yards.	Price per cubic yard.	Cost.
			Cents.	
2/25+20–2/42+20	308 R.	68,018.7	16.94	$11,522.36
9/47–13/9	316–319 R.	169,956.4	16.10	27,362.97
48/18–50/5	365 R.	67,287.2	14.00	9,420.21

These three contracts have been completed.

During the year the local levee boards did repair and enlargement work aggregating 170,000 cubic yards.

Summary of earth in place.

	In place Apr. 30, 1904.	Added during year.	In place Apr. 30, 1905.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
By United States	6,678,495	1,093,964	7,772,459
By local board	1,633,220	170,000	1,803,220
Total	8,311,715	1,263,964	9,575,679
Less levee abandoned			220,000
Net	8,311,715	1,263,964	9,355,679

Amount required to complete this levee system, about 7,500,000 cubic yards at an estimated cost of $1,500,000.

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Under the allotment of $200,000 from the new 1905–6 appropriation bids were opened on May 25 for 1,035,600 cubic yards of new and enlargement work, including the closure of the four 1897 breaks still remaining open. Satisfactory prices were obtained, and my recommendation for award has been forwarded for approval. (For further details, see report of Assistant Engineer M. Gardner, Appendix 2 E, herewith.)

GENERAL REMARKS ON LEVEE WORK.

During the past year notable progress has been made in the first and second districts toward the completion of the levee system, the United States and local boards having placed over 7,000,000 cubic yards of new and enlargement work. While considerable of this went for new loops, there has been a net gain of over 5,000,000 cubic yards, and the yardage required to complete has been reduced from about 28,000,000 to about 22,600,000. In considering the yardage necessary for completion it should be borne in mind, however, that the Commission grades will have to be raised along the lower St. Francis, White River, and upper Yazoo fronts, which will entail a considerable increase in the estimates for completion to ultimate grade and section.

The working season has been a notably good one, and nearly all contracts have been completed.

In the upper St. Francis district the upper 6 miles, just below Cairo, have been connected with the levee back of Wolf Island, with the exception of a gap about 2.2 miles long, which will be closed by the United States during the coming season, and two small gaps which will be closed by the local boards. This will give a continuous levee nearly 30 miles long below Cairo. At New Madrid, the lower end of this district, a levee board has recently been formed, and as soon as the necessary surveys are completed this board will begin the energetic prosecution of work at the lower end. The board at the upper end also expects to have a considerable sum available for additional levee work, and the present prospect is that with the usual Government assistance this levee district will be closed in within the next three or four years. It is recommended that the necessary Congressional authority be obtained for extending the jurisdiction of the Commission up to Commerce, Mo., as recommended by the Commission in its last annual report.

In the Reelfoot district about 13½ miles of levee have been constructed to the provisional grade, leaving a gap of 7½ miles, for the closure of which, at an estimated cost of $100,000, provisional authority has been granted for entering into contract, work to be done during the year the money becomes available. It can not, therefore, be constructed before July, 1906. The closure of this gap will result in forcing the full volume of flood water to pass around the peninsula opposite New Madrid instead of cutting across through Reelfoot Lake, as it now does, thus increasing the flood path over 20 miles. It is believed that this increase in the flood path will have a material effect on the flood heights below, and the result should be very carefully observed.

In the lower St. Francis district the Arkansas levee board has continued its effective work and has closed the gap between Cat Island and Bledsoe. During the coming year it will spend about $125,000 for additional work. While this district still needs over 6,000,000 cubic yards of earthwork to complete the system, the levee has been very materially strengthened in the last two years and should be able to stand a flood as high as that of 1903.

The upper Yazoo district has still by far the best levee north of Vicksburg, and the local board has continued its very effective work.

The White River district is still the lowest and weakest on the river, although it has been materially strengthened during the year. The new allotment of $200,000 will permit the closure during the coming season of the 1897 breaks still remaining open, which will be a great step in advance and will permit the immediate development of a large area now subject to overflow. It still is and for some time will be necessary to continue the policy of topping to the limit in this district in order to get the absolutely necessary grade to prevent overtopping.

In my last annual report (see Report of Chief of Engineers, 1904, Supplement, p. 150), I recommended that district officers be authorized to furnish engineering supervision and inspection without cost to the levee boards whenever requested, which recommendation is renewed.

Some progress has been made toward the systematic maintenance of levees, particularly in the upper Yazoo district, where practically the entire line and right of way have been fenced in. In Missouri and Arkansas, however, much

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difficulty is experienced, and it is probable that some prosecutions under section 14 of the river and harbor act of 1899 will be necessary before it is generally realized that the levees can not be trespassed upon with impunity. In the specifications for the coming season's work I have included the fencing of the right of way wherever new or enlargement work is undertaken, a course which will aid materially in protecting the levees from encroachment.

The following table shows, for the first and second districts, the yardage in place, yardage required to complete, and percentage of completed levee.

Levee district.	In system.	Built.	Contents in 1904.	Built since by United States.	Built since by local authorities.	Constructed in 1905.
	Miles.	*Miles.*	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*
Upper St. Francis	54	16.5	661,002	299,167	207,615	506,782
Reelfoot	20	9.6	789,131	229,680	50,000	279,680
Lower St. Francis	215	210.0	15,249,972	2,411,504	823,059	[a]3,084,563
Upper Yazoo	124	124.0	22,000,622	758,635	1,614,615	2,373,250
White River	74	72.0	8,311,715	859,747	170,000	[a]809,747
Total	488	432.1	47,102,442	4,558,683	2,865,289	7,053,972

Levee district.	Lost during year.	Contents in 1905.	Required to complete.	Estimated final contents.	Percentage now built.
	Cubic yds.	*Cubic yds.*	*Cubic yds.*	*Cubic yds.*	
Upper St. Francis	.....	1,167,784	4,294,764	5,462,548	0.177
Reelfoot	.....	1,068,761	1,236,658	2,305,414	.468
Lower St. Francis	150,000	18,334,595	6,163,146	24,497,681	.750
Upper Yazoo	.....	24,424,172	3,244,359	27,668,531	.882
White River	220,000	9,121,462	7,516,756	16,638,218	.548
Total	370,000	54,116,714	22,455,678	76,572,392	.705

[a] 150,000 cubic yards in lower St. Francis and 220,000 cubic yards in White River levee district lost by caving banks.

The above statement shows about 22,500,000 cubic yards necessary to complete the system in these districts. This estimate will be increased by several million yards when a new commission grade is adopted.

CAVING BANKS.

Caving banks are under observation in the first and second districts, as follows:

Slough Landing (60 L.).—(See map No. 18 herewith.) At this point and on the opposite side of the neck the river is attacking the bank, and a cut-off will occur within a few years unless prevented by revetment. Annual observations should be made, so that this work can be undertaken in ample time to prevent such a cut-off, which would throw out the loop passing New Madrid, which is 20 miles in length.

Pecan Point (196 R.).—(See map No. 19 herewith.) Heavy caving has occurred at this point during the past low-water season, and a loop will be necessary in the near future.

Harrisons Landing (220 R.).—(See map No. 20 herewith.) Caving has continued at this point, and a new loop is included in the project for the coming season.

Walnut Bend (280 R.).—(See map No. 15 herewith.) Rapid caving has continued at this point at a rate which will involve the levee within two or three years. If a cut-off into the St. Francis River at this point is to be prevented, a revetment must be constructed within the next year or two. The probable effect of such a cut-off is now being investigated and will be made the subject of a special report.

Old Town Bend (325 R.).—The caving bank at this point is within about 280 feet of the levee, and while the rate of caving is comparatively slow (about 100 feet per annum), it is likely at any time to increase, and in any case a loop will be necessary in the near future if the bank is not revetted. The levee at this point can be retired only about 800 feet, at a cost of about $75,000, and should

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caving continue to that point several miles of levee must be abandoned and a long and expensive line around Old Town Lake must be substituted. It is therefore evident that provision should be made for revetting this bank not later than the working season of 1906–7.

Below Fergusons Landing (366 R.) rapid but intermittent caving has been in progress during the year, and a new loop will probably be necessary in the near future.

SURVEYS.

The usual low-water surveys of bank revetments, caving banks, etc., have been made, and also the yearly surveys of the reaches below Random Shot and Hollybush crevasses of 1903, as explained in detail in the report of Junior Engineer L. L. Griffith (Appendix 2 F, herewith). The survey work under Mr. Griffith has been of especial value, and attention is particularly invited to the table accompanying his report.

INCLOSURES.

The following inclosures accompany this report, of which they are parts:

Appendix 2 A.—Report of Assistant Engineer A. J. Nolty on channel work in first district.

Appendix 2 B.—Report of Assistant Engineer W. M. Rees on channel work in second district.

Appendix 2 C.—Report of Assistant Engineer A. J. Nolty on plant, first and second districts.

Appendix 2 D.—Report of Junior Engineer D. M. Brock on levees, upper St. Francis and Reelfoot districts.

Appendix 2 E.—Report of Assistant Engineer M. Gardner on levees, lower St. Francis, upper Yazoo, and White River districts.

Appendix 2 F.—Report of Junior Engineer L. L. Griffith on surveys, first and second districts.

Map No. 1.—Columbus, Ky.
Map No. 2.—Hickman, Ky.
Map No. 3.—New Madrid, Mo.
Map No. 4.—Caruthersville, Mo.
Map No. 5.—Plum Point reach.
Map No. 6.—Daniels Point.
Map No. 7.—Ashport Bend.
Map No. 8.—Fletchers Bend.
Map No. 9.—Osceola bars.
Map No. 10.—Bullerton bar.
Map No. 11.—Hopefield Bend.
Map No. 12.—
Map No. 13.— } Memphis reach.
Map No. 14.—Memphis front.
Map No. 15.—Walnut Bend reach.
Map No. 16.—Helena reach.
Map No. 17.—Helena, Ark.
Map No. 18.—Slough Landing neck.
Map No. 19.—Random Shot break.
Map No. 20.—Hollybush crevasse.
Map No. 21.—
Map No. 22.—
Map No. 23.— } Maps showing existing levees.
Map No. 24.—
Map No. 25.—
Map No. 26.—
Map No. 27.— } Profile showing top of levee and high-water slopes.
Map No. 28.—
Map No. 29.—

Money statements, abstract of contracts in force, abstracts of proposals, and list of civilian engineers will be forwarded July 1.

Respectfully submitted.

E. W. VAN C. LUCAS,
Captain, Corps of Engineers.

Col. O. H. ERNST,
Corps of Engineers, U. S. Army,
President Mississippi River Commission.

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FINANCIAL STATEMENT.

Appropriation for improving Mississippi River, first and second districts.

HICKMAN, KY.

July 1, 1904, balance unexpended	$804.13
June 30, 1905, amount expended during fiscal year	275.50
July 1, 1905, balance unexpended	528.63
July 1, 1905, balance available	528.63

NEW MADRID, MO.

July 1, 1904, balance unexpended	$1,687.11
Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904	10,000.00
July 1, 1905, balance unexpended	11,687.11
July 1, 1905, balance available	11,687.11

CARUTHERSVILLE, MO.

July 1, 1904, balance unexpended	$178.98
June 30, 1905, amount expended during fiscal year	101.09
July 1, 1905, balance unexpended	77.89
July 1, 1905, balance available	77.89

PLUM POINT REACH.

July 1, 1904, balance unexpended	$346.99
Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904	100,000.00
October 27, 1904, amount refunded on account of erroneous payment in voucher 147, August, 1904	.31
June 23, 1905, amount deposited on account of error in footing of page 2, voucher 179, November, 1904	8.00
	100,355.30
June 30, 1905, amount expended during fiscal year	99,930.48
July 1, 1905, balance unexpended	424.82
July 1, 1905, outstanding liabilities	424.82

HOPEFIELD BEND.

July 1, 1904, balance unexpended	$57.89
Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904	120,000.00
	120,057.89
June 30, 1905, amount expended during fiscal year	119,987.60
July 1, 1905, balance unexpended	70.29
July 1, 1905, outstanding liabilities	70.29

MEMPHIS, TENN.

July 1, 1904, balance unexpended	$377.90
June 30, 1905, amount expended during fiscal year	377.90

MEMPHIS, TENN. (WOLF RIVER).

July 1, 1904, balance unexpended	$3,914.59
June 30, 1905, amount expended during fiscal year	3,561.10
July 1, 1905, balance unexpended	353.49
July 1, 1905, balance available	353.49

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HELENA, ARK.

July 1, 1904, balance unexpended	$346.66
Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904	10,000.00
	10,346.66
June 30, 1905, amount expended during fiscal year	7.95
July 1, 1905, balance unexpended	10,338.71
July 1, 1905, balance available	10,338.71

UPPER ST. FRANCIS LEVEE DISTRICT.

July 1, 1904, balance unexpended	$991.49
Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904	15,000.00
Amount allotted from appropriation for improving Mississippi River, river and harbor act approved March 3, 1905	30,000 00
	45,991.49
June 30, 1905, amount expended during fiscal year	16,549.33
July 1, 1905, balance unexpended	29,442.16
July 1, 1905, outstanding liabilities	24,865.00
July 1, 1905, balance available	4,577.16

LOWER ST. FRANCIS LEVEE DISTRICT.

July 1, 1904, balance unexpended	$49,716.89
Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904	140,000.00
February 20, 1905, amount received by transfer from third district, approved by Secretary of War February 13, 1905	15,000.00
Amount allotted from appropriation for improving Mississippi River, river and harbor act approved March 3, 1905	140,000.00
	344,716.89
June 30, 1905, amount expended during fiscal year	211,249.55
July 1, 1905, balance unexpended	133,467.34
July 1, 1905, outstanding liabilities	105,284.80
July 1, 1905, balance available	28,182.54

WHITE RIVER LEVEE DISTRICT.

July 1, 1904, balance unexpended	$16,023.32
Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904	70,000.00
Amount allotted from appropriation for improving Mississippi River, river and harbor act, approved March 3, 1905	200,000.00
	286,023.32
June 30, 1905, amount expended during fiscal year	51,174.36
July 1, 1905, balance unexpended	234,848.96
July 1, 1905, outstanding liabilities	180,488.20
July 1, 1905, balance available	54,360.76

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UPPER YAZOO LEVEE DISTRICT.

July 1, 1904, balance unexpended	$46,152.24
Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904	70,000.00
	116,152.24
June 30, 1905, amount expended during fiscal year	102,856.94
July 1, 1905, balance unexpended	13,295.30
July 1, 1905, outstanding liabilities	200.00
July 1, 1905, balance available	13,095.30

REELFOOT LEVEE DISTRICT.

July 1, 1904, balance unexpended	$1,237.03
Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904	15,000.00
	16,237.03
June 30, 1905, amount expended during fiscal year	16,235.17
July 1, 1905, balance unexpended	1.86
July 1, 1905, balance available	1.86

SURVEYS, FIRST AND SECOND DISTRICTS.

July 1, 1904, balance unexpended	$207.54
Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904	5,000.00
	5,207.54
June 30, 1905, amount expended during fiscal year	5,197.76
July 1, 1905, balance unexpended	9.78
July 1, 1905, balance available	9.78

PLANT, FIRST AND SECOND DISTRICTS.

July 1, 1904, balance unexpended	$2,410.25
Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904	50,000.00
January 28, 1905, amount allotted, being proceeds from sale of engineer property	1,275.42
March 4, 1905, amount allotted, being proceeds from sale of engineer property	68.00
April 12, 1905, amount allotted, being proceeds from sale of engineer property	46.75
May 25, 1905, amount allotted, being proceeds from sale of engineer property, approved by Secretary of War, May 20, 1905	79.10
	53,879.52
June 30, 1905, amount expended during fiscal year	53,023.83
July 1, 1905, balance unexpended	855.69
July 1, 1905, outstanding liabilities	855.69

APPROPRIATION FOR REPAIRING GOVERNMENT LEVEE AT WALNUT BEND, ARK.

July 1, 1904, balance unexpended	$84,989.72
June 30, 1905, amount expended during fiscal year	82,428.78
July 1, 1905, balance unexpended	2,560.94
July 1, 1905, outstanding liabilities	560.94
July 1, 1905, balance available	2,000.00

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APPROPRIATION FOR EMERGENCIES IN RIVER AND HARBOR WORKS.

Amount allotted for Wolf River, act approved April 28, 1904	$8,000.00
June 30, 1905, amount expended during fiscal year	8,000.00

APPROPRIATION FOR EXAMINATIONS, SURVEYS, AND CONTINGENCIES OF RIVERS AND HARBORS FOR PRELIMINARY EXAMINATION NEAR ASHPORT, TENN.

Amount allotted from river and harbor act approved March 3, 1905	$25.00
July 1, 1905, balance unexpended	25.00
July 1, 1905, balance available	25.00

APPROPRIATION FOR EXAMINATIONS, SURVEYS, AND CONTINGENCIES OF RIVERS AND HARBORS, FOR SURVEY, PLAN, AND ESTIMATE (ASHPORT, TENN.).

Amount allotted from river and harbor act approved March 3, 1905	$460.00
July 1, 1905, balance unexpended	460.00
July 1, 1905, balance available	460.00

MISCELLANEOUS.

December 19, 1904, amount received from rent of Government barges	$50.00
January 11, 1905, amount received from sale of engineer property	1,275.42
February 11, 1905, amount received from sale of engineer property	68.00
February 20, 1905, amount received from B. F. Dame for rent of island in Mississippi River near Australia, Miss., for year ending February 24, 1906	1.00
March 22, 1905, amount received from sale of engineer property	46.75
	1,441.17

December 19, 1904, amount deposited to credit Treasurer United States on account rent of Government barges	50.00
January 11, 1905, amount deposited to credit Treasurer United States on account sale of engineer property	1,275.42
February 11, 1905, amount deposited to credit Treasurer United States on account sale of engineer property	68.00
February 20, 1905, amount deposited to credit Treasurer United States on account rent of island in Mississippi River near Australia, Miss., for year ending February 24, 1906	1.00
March 22, 1905, amount deposited to credit Treasurer United States on account sale of engineer property	46.75
	1,441.17

Abstract of contracts in force June 30, 1905, in first and second districts, improving Mississippi River.

Names of contractors.	Amount and character of work.	Rate.	Date of approval.	Date of beginning work.	Date of expiration of contract.
G. W. Fisher	Rent of river front, Memphis, Tenn.	[a] $50.00	Emergency contract.	Apr. 1, 1905	Mar. 31, 1906
Fannie W., and Wm. E. Everest.	do	[a] 100.00	do	do	Do.
Chas. H. Boyle	do	[a] 50.00	do	do	Do.
Phil. J. Howard & Son.	10,000 cubic yards stone.	[b] .60	do	May 15, 1905	July 15, 1905

[a] Per annum. [b] Per cubic yard.

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APPENDIX 2 A.

REPORT OF MR. A. J. NOLTY, ASSISTANT ENGINEER ON CONSTRUCTION WORK IN FIRST DISTRICT DURING SEASON OF 1904–5.

MEMPHIS, TENN., *May 1, 1905.*

CAPTAIN: I have the honor to submit my report of operations of the construction parties operating in the first district for the season 1904–5.

Early in the summer arrangements were made by the district officer with Messrs. Phil J. Howard & Son and W. T. Downey, both owning quarries at Rosi Clare, on the Ohio River, 92 miles above Cairo. No formal contracts were made, the transactions being in open market. The Howards agreed to deliver riprap stone of specified dimensions upon the United States barges at 60 cents per cubic yard, and quarry spalls at 50 cents. Downey's price was 50 cents for both riprap and spalls, the United States to furnish an inspector and the necessary watchmen, the barges to be loaded as directed by the inspector. The Howards owned three quarries, covering about 1½ miles of river front, while Downey had one. The former parties were experienced quarrymen, while Downey was more of a farmer than a quarryman.

Unfortunately there were several bad shoals between Cairo and the quarries, and the very early advent of low water in the Ohio made towing both difficult and expensive. Then, too, the difficulty of keeping a sufficient force of men at the quarries caused delays to the towboats and often compelled them to leave with short tows. In the early part of July towing became so difficult that operations in that river were suspended July 10 and all plant towed out. The Howards furnished 4,256 cubic yards of riprap and spalls, and Downey 1,567 cubic yards.

Foreseeing the early closure of the Ohio, the district officer had in the meantime made arrangements with C. C. Huthmacher, of Grand Tower, Ill., to furnish stone at the same price and under the same conditions as the Howard agreement. Barges were sent to the quarry opposite Grand Tower on July 7, and as there was already a quantity of quarried stone on hand, work of loading was begun on the following day. It soon became evident that Huthmacher had agreed to perform more than he was able to do, for, being under a penalty contract with the St. Louis works and under no contract with us, his main effort was directed toward filling the requirements of his contract, and hence our barges were only loaded when he had none on hand for the other work. As he was always short of labor his entire output was but little more than his contract requirements. Arrangements were then made with him to furnish us with quarried stone on the floor, we to do the breaking up to proper size and the loading. This stone was furnished at 30 cents per cubic yard. He was also to continue loading on barges as heretofore. To carry out this arrangement properly he opened another quarry behind Tower Rock; but even with the two quarries working the outcome was scant, and much delay was caused to our loading party by reason of the quarry output frequently failing. The delays to the towboat were frequently so long that the boat was cooled down while waiting for a tow in order to save fuel. Any delay at the quarry of course reacted unfavorably upon the unloading party at Fletchers Bend, and in order to reduce the periods of idleness of that party as much as possible the towboat frequently left the quarries with two and three barges when an economical tow was from eight to ten pieces. Huthmacher loaded upon our barges 3,494 cubic yards, while our hired force loaded 3,977 cubic yards. Stone towing was finally suspended on September 9, by which time the river between Cairo and Grand Tower had become so shoal that only light loads could be taken out.

A total of 13,294 cubic yards were towed out of both rivers. Of this about 10,000 yards were stored on the bank at Fletchers Bend, while the balance was kept afloat and used direct on the work.

While the laborers at the stone depot were only paid when actually at work, they had to be subsisted during periods of enforced idleness. The pay of foremen, watchmen, inspectors, and towboat crews was continuous during the month, and these items, together with the cost of fuel consumed, have largely increased the cost of the stone as finally expended upon the work.

Considering the actual towing time of the towboat, the cost for towage to Fletchers Bend was 35 cents per cubic yard, while when the time lost in waiting at the quarries is taken into account (and this, of course, is the actual cost to us), the towage per yard comes to 59.3 cents. There is no doubt that could the

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boat always have had a full tow when it arrived at the quarries the cost per yard would not have exceeded 32 cents.

In the future it will be found to be much more economical if contracts or other arrangements for the furnishing of stone upon our barges could be made at such an early date that the bulk of the stone would be at the depot before the advent of low water.

It speaks well for the skill and carefulness of the master and pilots of the towboat that despite the low water and difficult navigation neither boat nor barges sustained the slightest injury while towing.

Some device for unloading and reloading the stone would reduce the cost of handling at the depot very considerably. Probably the cheapest device would be a floating steam derrick with a long reach of boom. This machine would not only unload and reload the stone, but could also be used for dumping the stone on the graded bank handy for the pavers. Of course the unloading for storage would have to be done on a revetted bank, as no floating derrick could be built with a reach sufficient to store the stone far enough behind a caving bank to make it reasonably safe against caving into the river.

Total amount of stone received during 1904, 13,294.29 cubic yards, distributed as follows:

	Riprap.	Spalls.
	Cubic yards.	*Cubic yards.*
From Phil J. Howard & Son, Rosi Clare, Ill.	3,542.27	713.90
From W. . Downey, Rosi Clare, Ill.	1,568.92	----------
From C. C. Huthmacher, Grand Tower, Ill.	2,548.29	946.21
From C. C. Huthmacher, Grand Tower, Ill., quarried by him, but loaded on barges by United States hired force	3,945.19	31.71
Total	11,602.67	1,691.62

The cost of towing from quarries to Fletchers Bend, Ark., was as follows:

From Rosi Clare quarries, inclusive of time lost by towboat waiting for loaded barges, $0.593 per cubic yard. Cost, including actual towing time only. $0.523.

From Grand Tower quarries, inclusive of time lost waiting for loaded barges, $0.56 per yard. Cost, including actual towing time only, $0.355 per cubic yard.

Cost of Rosi Clare stone upon barges, 5,823.09 cubic yards	$3,337.16
Pay roll, inspector and watchmen	293.83
	3,630.99

Cost per cubic yard on barges, $0.623.

Cost of Grand Tower stone, loaded by C. C. Huthmacher, 3,494.30 cubic yards	$2,001.98
Pay roll, inspector and watchmen	208.50
	2,210.48
Cost of Grand Tower stone, loaded by United States, 3,976.90 cubic yards, quarried, at $0.30 per cubic yard	1,193.07
Cost of sledging and loading on barges	4,056.44
	5,249.51
Cost of sledging and loading per cubic yard	$1.02
Cost per cubic yard on barges	1.32
Cost per cubic yard of Rosi Clare stone delivered at Fletchers Bend	1.216
Cost per cubic yard of Huthmacher stone delivered at Fletchers Bend	1.192
Cost per cubic yard of stone loaded by United States delivered at Fletchers Bend	1.88

Average cost of all stone delivered at Plum Point, $1.429+ per cubic yard.

Cost per cubic yard for unloading and reloading, $0.43+. Cost per cubic yard put on work, $1.86.

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PLUM POINT REACH.

Osceola bar.—The project for the season's work included the placing of about 2,000 linear feet of standard revetment along Upper Osceola bar, beginning at a point about 500 feet above the mouth of the chute and running thence downstream far enough to lap over the head of Lower Osceola bar. In 1895 there were placed along here 3,750 feet of standard revetment, but within five years after construction this had been practically destroyed by reason of the downstream traved of the erosion of the unprotected bank above. In 1902 an attempt was made to place about 1,200 feet of revetment, but owing to a variety of adverse conditions work was suspended after losing about 600 feet of mat. Erosion had by this time cut away the bank of the bar so much that at one place the river stood against the main shore. In 1903 the repair of the Fletcher Bend revetment being considered more important, and especially as but very little change had taken place along Osceola bar, no work was done at the latter place. An examination made early in 1904 showed that practically no change had taken place here, and as there were then indications that the channel heretofore running close to the bar might close up, the execution of the project was again deferred. An examination made later in the season, and at a very low stage of river, gave no evidence of recent caving, and soundings and surface indications tended to confirm the belief that the channel would shift over toward the middle of the river, which, of course, would render revetment of the bar shore unnecessary.

This locality should, however, be kept under careful observation in order to prevent any possibility of the reopening of Osceola and Bullerton chutes.

Fletchers Bend.—The work mapped out for the season was the continuation of the replacement of the old type of revetment placed in 1890–91, part of which was entirely and a portion partially destroyed, with the standard type as far as the funds available would permit.

The reconstruction of this revetment was begun in 1902, but owing to the lateness of beginning work that year only 770 feet were renewed. In the following year an additional 1,483 feet were placed, and during the past season 2,182 feet were added to the work of the two previous seasons, and 662 feet were placed at the foot of the old work, making a total for the season of 1904–5 of 2,844 feet of standard revetment, leaving about 2,300 feet of fairly good old-type revetment between. This should be renewed during the present year in order to save all of the upper bank revetment which is still in good shape.

Four mats were required to make up the above length of revetment, No. 4 being 1,082 feet long; No. 5, 683 feet; No. 6, 563 feet, and No. 7, 662 feet, making a total of 2,894 feet of mat. The excess of length of mat over length of revetment is accounted for by overlapping of the contiguous mats. At the foot of the Fletchers Bend continuous revetment, where mat No. 7 was placed, much of the old upper bank protection above the 9-foot stage was still in good condition, and to avoid disturbing this by regrading the caved-off strip of bank in front of the mat a wall of dry riprap with a batter on the face was built up to a little above the surface of the undisturbed paving. This wall was made 1½ feet thick at the base, tapering to 9 inches at the top. A similar method of revetting a damaged section of revetment had been applied in 1892 at Daniels Point, and as the saving effected in avoiding the tearing up of the intact paving would be considerable it was thought that the application of this expedient was justified. All river mats were built 250 feet wide.

Seven connecting mats were required for the purpose of making proper connection between the high and low water bank protection at such places where the bights in the shore line were too deep laterally to permit the weaving of the proper curvature into the river mat. One of the seven was placed at the foot of mat No. 7 to check the further upstream travel of bank erosion at the lower extremity of the section. One connecting mat was also placed in the 1899 work to cover a cave, and some additional stone was placed at a few places where the paving had been displaced by running drift or ice.

While the bank was being graded near the foot of mat No. 4 a sudden sliding out of the bank occurred, involving to some extent the subaqueous work by displacing it. Soundings taken immediately after the cave and also on the following day showed that while the mat received no structural damage it was very much displaced, both laterally and vertically, so much so that a connecting mat, 90 feet wide at its greatest width and 182 feet long, was subsequently required to repair the damage. It was found that the graded bank in front

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of the cave was very soft, with considerable seep water flowing. The source of this seepage was traced to an old crevasse hole in the rear of the old State levee situated about 700 feet behind the bank. The area of this hole was considerable, and the depth of water contained therein was as much as 12 feet, which gave a head above the zero of the gauge of 17 feet. The amount of fill required to close this hole was 4,400 cubic yards. The filling was done by the levee repair force, working under the immediate supervision of Assistant Engineer Le Vasseur.

With the exception of the cave just described, there were no losses, damages, or unusual difficulties of construction, the entire working season being an almost ideal one as regards weather and stage of river. Labor, too, was plentiful and of good quality. Stone was, of course, always on hand as wanted, and plant was ample and in good shape. The brush supply, however, was not always up to the demands of the work, as the contractors seemed unable to hold their labor. A mat party building a full-width mat should always have two barges of brush behind the weaving barges to work from. Whenever they have only one barge to work from, the mat force must be reduced, otherwise they will be in each other's way in carrying brush. I apprehend that so long as the contractors work their labor from daylight to dark they will have labor troubles, and I believe that if they adopted the eight-hour day they would obtain a better class of men, who will remain with them for some time and thus avoid the necessity of their changing the entire working force about once a week and being sometimes reduced to a half dozen men when they ought to have 50.

Construction work in Fletchers Bend was begun on September 3 and consisted in clearing the bank to be revetted of all standing timber, brush, drift, etc. This was done by the unloading party at such times when they were out of stone. Mat construction was begun with mat No. 4 on September 10. This mat was made 1,082 feet long and was so placed that its lower end would overlap that part of the old work still in a fair state of preservation and whose reconstruction was to be postponed for another year. Mat No. 4 was sunk October 1.

Mat No. 5 was begun October 8, the interim between the 1st and 8th being employed in placing three connecting mats required in front of mat No. 4. No. 5 was sunk on the 21st of October. Its length is 683 feet. Two connecting mats were required here, and upon completion of these and the one required to cover the fault in mat No. 4, No. 6 was begun on the 28th of October, being sunk November 5. Its length is 563 feet, and it connects at its upper end with the work of 1903.

Mat No. 7, which, as already stated, lies at the foot of the Fletchers Bend continuous revetment at what was formerly known as section "A," was begun on November 12 and sunk November 26. It is 662 feet long. One connecting mat was placed at the extreme end, as already described. A map with the season's work platted thereon is submitted herewith.

As soon as all the mat work had been completed, the entire mat plant, together with one quarter boat, one pile driver, and four material barges, were assembled ready for towing to Longwood, Miss. The overseer, together with the foremen working on mat construction, 90 laborers, and the kitchen personnel were sent with the outfit, which left on November 29 in tow of third district steamer *Arthur Hider*.

Grading and paving of bank were done in the usual manner and carried up to the 23-foot contour.

The force, reduced by the draft of men for Longwood, was allowed to gradually reduce itself, so that on the day of completion of the season's work on December 29 there remained but 40 laborers. All construction plant was in Memphis by the last day of the year.

REPAIRS TO EXISTING WORK.

Daniels Point.—A small fault near the foot of the 1895 revetment was repaired by regrading and repaving, the damage being above the low-water margin. There were used 130 cubic yards of riprap and spalls.

Toward the close of the working season another fault developed a short distance above the one repaired. The proper repair of this work would require a connecting mat, but as the mat plant was then at Longwood, Miss., nothing in the way of repairs was done. It is not believed that this fault will increase materially before it can be properly repaired during the coming working season.

Bullerton Towhead.—A small fault near the extreme end of this revetment was repaired by repaving. The fault was in the nature of displacement of the

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stone by either running drift or ice. One hundred and thirty cubic yards of riprap and spalls were expended.

This is the first expenditure for maintenance of this work since its construction in 1893–94.

Fletchers Bend.—A fault of some magnitude developed in the 1899 work, which lies in a very strong eddy primarily caused by the heavy submerged spur lying just above. The repair of this involved the construction of a connecting mat 58 feet wide by 213 feet long, 1,041 cubic yards of grading, and 1,073 square yards of paving.

There is appended a summary of work done during the season and the cost of the same.

I would respectfully recommend the following work in Plum Point reach for the ensuing working season. This recommendation is based upon the assumption that the declining river will show no material change in the conditions at Osceola bar. Should it be found that changes inimical to the regimen of the the river have taken place it may become necessary to postpone all or part of the work here recommended.

Between the foot of mat No. 4 and the head of No. 7 there lies 2,300 linear feet of unreconstructed old-type revetment. When last seen the upper bank protection along this stretch was in very good condition, but the subaqueous work showed unmistakable signs of disintegration along the low-water margin. If the subaqueous work is replaced this season with the standard type, very little, if any, work will be required on the upper protection, thus effecting a material saving in cost. This work is therefore recommended as urgent.

Below the foot of mat No. 7 lies the "interrupted" revetment of Major Leach, which was placed in 1888 and 1889 and which is now so badly broken up that it would offer but little resistance against the erosive efforts of the current, should any greater strain be thrown against it. This should be reconstructed with standard-type work. About 5,000 linear feet would be required and then Fletchers Bend would be safe for a long time to come.

The cost of the 2,300 feet between mats Nos. 4 and 7 is estimated at $18 per linear foot, or a total of $45,000. The cost of the lower 5,000 feet is estimated at $25 per linear foot, or $125,000 for the 5,000 feet.

If there were any possibility of obtaining funds therefor, I should strongly repeat my recommendation for the closure of Gold Dust Chute with a system of abattis dikes thrown from the head of Island 30 to the main shore and toward Elmot bar. There is a very apparent increase in the discharges through Elmot and Island 30 chutes, and with the aging of the obstructions at the head of the main chute this danger of a reopening is increased.

Field cost of new work, Fletchers Bend.

Labor, superintendence, and subsistence	$33,719.81
Stone, 12,794.29 cubic yards, at $1.86	23,797.38
Brush, 12,147.50 cords, at $1.12	13,605.20
Poles, 42 cords, at $2	84.00
Poles, hard-wood, 223, at $0.333	74.33
Wire strand, ½-inch, 12,843 pounds, at $0.0325	417.40
Wire strand, ⅜-inch, 6,507 pounds, at $0.0239	155.52
Wire strand, 7/16-inch, 20,318 pounds, at $0.0283	575.00
Wire strand, ½-inch, 54,253 pounds, at $0.0344	1,866.36
Silicon bronze wire, 1,510 pounds, at $0.18	271.80
Galvanized wire, 14,566 pounds, at $0.022	320.45
Clips, ½-inch, 1,169, at $0.0849	99.25
Clips, ⅜-inch, 844, at $0.0799	67.44
Clips, 7/16-inch, 4,936, at $0.0780	385.00
Staples, 1,265 pounds, at $0.0235	29.73
Lumber, 9,400 feet B. M., at $13.24 per thousand	124.53
Coal, 5,933.5 bushels, at $0.10	593.33
Cordage	1,743.80
Towing	7,466.50
Miscellaneous materials	379.90
Oils and engineer supplies	200.75
Quarter-boat equipage, tools, and appliances	809.01
Transportation	831.76
Total	86,870.27

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Summary of new work at Fletchers Bend.

Channel mat No. 4, 1,082 by 250 feet, 2,705 squares, at $7.92	$21,436.95
Channel mat No. 5, 683 by 250 feet, 1,707.5 squares, at $7.05	12,039.96
Channel mat No. 6, 563 by 250 feet, 1,407.5 squares, at $7.83	11,019.85
Channel mat No. 7, 662 by 250 feet, 1,655 squares, at $7.92	13,116.55
	57,613.31
Connecting mats, 768.4 squares, at $10.04	7,718.11
Hydraulic grading, 2,609 linear feet=55,765 cubic yards, at $0.038	2,131.68
Paving bank, 2,609 linear feet=17,109.75 square yards, at $1.06	18,177.75
Filling water hole, 4,400 cubic yards, at $0.279	1,229.42
Total	86,870.27

Repairs to existing works.

Daniels Point	$575.55
Fletchers Bend	1,593.41
Bullerton Tow-head	484.45
Total expenditures for the season	89,523.68

Stone unloaded at Fletchers Bend and afterwards reloaded onto barges, 10,155 cubic yards.

Field cost of repair work.

Labor, including superintendence and subsistence	$1,153.91
Stone, 500 cubic yards, at $1.86	930.00
Brush, 100 cords, at $1.12	112.00
Poles, 30 cords, cut by hired labor and included in labor cost	
Wire strand, $\frac{5}{16}$-inch, 316 pounds, at $0.0283	8.94
Wire strand, $\frac{1}{4}$-inch, 881 pounds, at $0.0344	30.31
Galvanized wire, 229 pounds, at $0.022	5.04
Clips, $\frac{3}{8}$-inch, 24, at $0.0799	1.91
Clips, $\frac{5}{16}$-inch, 138, at $0.078	10.77
Staples, 35 pounds, at $0.0235	.82
Lumber	.84
Cordage	8.04
Towing	388.52
Miscellaneous materials	2.31
Total	2,653.41

Respectfully submitted.

AUG. J. NOLTY, *Assistant Engineer.*

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

APPENDIX 2 B.

REPORT OF MR. W. M. REES, ASSISTANT ENGINEER, ON CONSTRUCTION WORK IN SECOND DISTRICT DURING SEASON OF 1904–5.

MEMPHIS, TENN., *May 1, 1905.*

CAPTAIN: I have the honor to submit a report upon the channel works under my charge at Hopefield Bend, Ark., and Wolf River, Tenn., during the year ending March 31, 1905.

HOPEFIELD BEND.

For a general description of this work see Report of the Chief of Engineers for 1904, Supplement, page 166 et seq.

Briefly, at the close of the working season of 1903–4, there was in place 2,718 linear feet of revetment constructed that season near the upper end of the bend to replace the old 1883 and 1884 revetments which had been destroyed by caving, but of this about 250 feet at the upper end and 170 feet at the lower

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end was of narrow mattresses, built principally to prevent the main revetment from being flanked by caving. Hence, there was practically in place here but 2,300 linear feet of full-width revetment.

Below this there was a caving bank for about 1,000 feet down to the remaining portion of the 1885 revetment, and this, then about 600 feet long, was rapidly disintegrating. Then came 840 linear feet of revetment of the old woven type, built in 1891, with mattresses 220 feet wide, and still intact. Next below this was 840 linear feet of similar work, built during the same season, but which had failed and was reconstructed last season with narrow fascine channel mats 116 feet wide. From this down to the head of the fascine mat work of 1899, a length of 2,300 feet, the revetment was of the old-type mat, built in the years 1887, 1891, and 1892, with a good pavement along them to the top of the bank. This latter section was subject to swift currents during high-water stages, and had broken in several places and been repaired in 1903. Below this there was 6,600 linear feet of fascine-mattress revetment, built in 1893 and 1899 and extending some distance below Hopefield Point. This has afforded good protection, the failures along it being of only minor character and cheaply repaired.

The high flood of 1904, reaching 39 feet on the Memphis gauge, did no damage to the new revetment of 1903, the protective works at the ends holding effectively, and while there was some extension of the caving along the unprotected bank at the upper end, this was much less than anticipated, being only about 200 feet in length, and the caving back into the bank being relatively small. In the gap below the new revetment the caving was quite active, and encroached considerably into the bank.

The remaining 1885 revetment failed completely, and three large pockets caved out of the upper section of the 1891 revetment, practically destroying it, but no damage was done to the section below this which had been reenforced in 1903. The upper portion of the 2,300-foot section of old-type work below this was uninjured, but along the lower portion, over a length of about 1,000 feet, there were numerous settlings near the low-water line, some involving the paving to above mid stage.

Some minor damage occurred to the fascine revetment below station 40 E., principally to the paving, which settled in some places where the slope was quite steep, and at other places was displaced by ice or drift. Just at Hopefield Point there was a small settling, necessitating the building of a small connecting mat for repairs, and later in the season (February, 1905) there was a small break at station 60 E., attributed to the ice displacing the paving and permitting scour of a very sandy bank. This also required a mattress for its repair.

For repairing and strengthening the Hopefield Bend revetment the Commission allotted the sum of $120,000, which was expended in executing the following project:

(1) To revet the gap below the upper work of 1903–4 and extend the same down along the broken upper section of the 1891 revetment to join onto the reenforced work of last season.

(2) To make necessary repairs along the fascine mattress revetment below station 40 E.

(3) To reenforce, as far as funds would permit, the remaining old-type revetments, such reenforcement to be with fascine mats of full width to reach deep water, or about 250 feet wide, and to restore the broken or settled pavements.

The work done under this project consisted in revetting the gap and the broken bank below, a length of 2,440 feet, with channel mats 254 feet wide; extending the reenforcing work of 1903 downstream to station 19 + 15 E. with a narrow channel mat 127 feet wide and 245 feet long, and reenforcing the old work between stations 28 + 50 E. and 39 + 82 E. with a mat 254 feet wide and 1,132 feet long. The bank was paved along all of these mattresses or the paving reconstructed. In addition, 602 linear feet of old revetment was repaired, principally the paving, and four old barges sunk in pockets to break up strong eddies.

CONSTRUCTION.

CHANNEL MATS.

The first tow of plant was delivered August 31, and work begun the following day in clearing the bank of timber. Some of this had been cut in June but not removed, and additional caving necessitated further clearing. Numerous trees and stumps had also caved into the river, making obstructions which had to be

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removed before mattresses could be placed. The towing steamer cleared these from the lower part of the gap, but those along the upper part, being quite large, were removed by the regular snag boat, which also removed the shaft, wheel, and part of the hull of a steamer wrecked along the head of the 1891 work. Upon the arrival of wire strand, which had been delayed, mattress construction was begun September 8. This mattress (No. 6) was built along the lower part of the gap between stations 0 and 7 W. It was much curved to fit the very irregular shape of the bank, was 730 feet long inside and 775 feet long outside, length of 752 feet and 254 feet wide, and was finished and sunk September 24 when the river was at the 6-foot stage and the current velocity 6.4 feet per second.

Channel mat No. 7 was begun October 3 and sunk October 22. It is 925 feet long by 254 feet wide and protects the bank between stations 7 W. and 16 W. This mat was also considerably curved to fit irregularities of bank. The current here was quite swift, so it was designed to withstand a 7 foot per second current, but at the date of sinking the river fell to the 3.1-foot stage, and the current velocity decreased to 5.7 feet.

Channel mat No. 8 was begun October 27 and sunk November 17. It is 930 feet long and 254 feet wide, curved to fit the bank, with an offset at the head 45 feet by 32 feet, around a point, and revets the bank along the 1891 work from stations 0+10 W. to 8+40 E., lapping onto mat No. 6 of this season and mat No. 5 of 1903–4. The stage at date of sinking was 4.4 feet and current 5.4 feet per second.

Channel mat No. 9 was begun November 25 and sunk December 15. It is 1,132 feet long by 254 feet wide, located between stations 28+50 E. and 39+80 E., along old revetment of 1892, and laps onto the fascine mat of 1899. It was sunk at a 2.2-foot stage, with current velocity of 3 feet per second.

Channel mat No. 10 was begun January 2, 1905, and sunk January 7. This is a narrow mat 127 feet wide by 245 feet long, located between stations 16+70 E. and 19+15 E. and lapping the lower end of mat No. 5 of 1903. It was sunk at the 7.4-foot stage in slack current.

CONNECTING MATS.

Although the channel mats were fitted as closely to the shore as practicable, many connecting mats were required to unite them with the irregular shore line. In all, sixteen of these were built, aggregating 1,342.46 squares. Of these, five, measuring 781.12 squares, were placed in the gap; three, measuring 151.6 squares, along mat No. 8; five, measuring 300.04 squares, along mat No. 9; one of 68.3 squares, at stations 60 and 61; and one, of 41.4 squares, at Hopefield Point. The channel and connecting mats were of the usual fascine construction.

Shore mats and drains.—At two localities, one between stations 7 and 8 W. and the other between stations 13 and 13+40 W., the bank had sloughed, due to seep water, leaving loose and somewhat unstable earth for a paving foundation. As it was not considered safe to pave directly on this, it was first covered with a grillage of brush three layers thick, which was then covered lightly with stone. Between stations 13 and 13+40 W., 90 linear feet of drain ditches, of 4 feet by 6 feet sections, were dug and filled with brush.

Four shore mats were built, covering an area of 98.15 squares, and the brush filling of drains equaled 21.6 squares.

Grading.—This was done by the hydraulic method, the grade of slope being about one on three, but flatter at points, and steeper in bights of shore pockets. The slope was not graded to the top, a shoulder of 6 to 8 feet vertical height being left there. The work was much interrupted on account of interference of mat plant and lines. In all, 1,120 linear feet of bank was graded, removing 33,000 cubic yards, all of this being in the gap between stations 1 and 14 W. Considerable hand grading was done, the total being 26,342 square yards of bank dressed and graded.

Paving.—This was of the usual construction, from 6 to 7 inches of closely pitched riprap on a bed of 3 to 4 inches of quarry spalls, but, owing to the short supply of the latter, these were omitted in some places where the bank was of hard or buckshot clay. Where the bank was of sand or of a sandy nature spalls were always used.

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In the gap, and in large pockets along mat No. 8, the paving was in general extended to the 25-foot stage, though in some places not quite so high, but it was always lapped onto the hard top stratum of buckshot clay.

The following are quantities laid:

	Square yards.
Along mats Nos. 6 and 7, stations 0 to 14+60 W	13,345
Along mat No. 8, stations 0 to 8+50 E	3,713
Along mat No. 9, stations 28 to 40 E	2,794
Between stations 40 and 43 E	1,238
Between stations 49 and 50 E	690
Between stations 65 and 66 E	462
Between stations 98+40 and 99+60	423
Total new paving laid	22,665

Bank repaved, i. e., stone removed, bank graded, and stone relaid:

	Square yards.
Along mat No. 9, stations 28 to 40 E	2,753
Along mat No. 10, stations 16+70 to 19+15	390
Above mat No. 9, stations 27 to 28	122
Total paving relaid	3,265

Barges sunk.—Four old and condemned barges were sunk in pockets with the object of reducing eddy currents, to which the slipping tendency of the bank was attributed. They were located at stations 4+79 E., 40+39 E., 41+42 E., and 50+47 E.

Material and labor.—Brush and poles were supplied by contract f. o. b. Government barges for $1.08 per cord for the former and $2 per cord for the latter. The supply was short of requirements during part of October and up to November 9, when contractors moved to a large and accessible brush bar 42 miles below the work, and thereafter the supply was plentiful. During October 158 cords of brush were cut by hired labor at a cost of $1.32 per cord.

Stone was supplied by contractor on his own barges delivered at the works at $1.69 per cubic yard for both riprap and spalls. The source of supply was from both the Mississippi and Ohio rivers above Cairo. The deliveries were not up to the requirements, as, owing to many quarries on the Mississippi River having been ruined by the new railroad built in front of them, the supply from that source was curtailed, and the Ohio River was too low for navigation for a great part of the season. To supply the shortage the contractor purchased some stone by railroad, delivered on his own barges at Memphis, and the Government bought some stone, f. o. b. cars on siding at Hopefield Bend, at $1.55 per gross ton, and loaded same on barges, charging the excess in cost to the contractor.

During the early part of the season negro laborers only could be had. These were paid $1.50 per day, without board. In October a few white men were hired at $1 per day and board. These were not efficient, each staying but a few days. In an attempt to secure a better class of men the wages of whites were increased to $1.20 per day and board, and to keep up a better attendance of negro laborers their ferry transportation from Memphis to the works, costing 15 cents per man per day, was paid by the Government.

In general.—The low stage of the river, which prevailed during the entire working season, permitted the sinking of mattresses in the gap and just below with safety, whereas at higher stages this would have been difficult and risky on account of the swift current.

The work was delayed by shortage of brush and by slow deliveries of stone. Rain late in December and in January retarded progress, and on January 15 running ice compelled the removal of all plant to Wolf River. This was moved back to the "Bend" on the 20th and work resumed; but on the 25th a second run of ice caused another removal of the plant to Wolf River, where it was kept until the ice ran out on February 20, when work was resumed with a small force and finished on February 28, 1905, this closing the season.

To complete the work at this locality will require the reenforcement of about 1,000 linear feet of old-type, woven-mat revetment, the extension of the paving along 5,000 linear feet of recent work, now at about the 25-foot level, to the top of the bank, and the probable extension of the present work about 1,000 feet upstream.

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The amount of work done and cost is shown below.

Extent of work and cost in detail.

NEW WORK.

Five channel mats, containing 9,786.73 squares:		
Brush, 14,789.33 cords	$15,972.48	
Brush (cut by labor), 158.30 cords	209.39	
Poles, 595.03 cords	1,190.06	
Poles (hard wood), 473	201.98	
Stone riprap, 5,555.58 cubic yards	9,388.93	
Stone riprap (from stock), 625.40 cubic yards	409.58	
Stone spalls, 190.06 cubic yards	321.20	
¼-inch wire strand, 58,780 pounds	2,012.03	
5/16-inch wire strand, 34,159 pounds	1,001.18	
⅜-inch wire strand, 5,430 pounds	128.70	
½-inch wire strand, 32,560 pounds	1,059.89	
No. 12 wire, 24,700 pounds	553.13	
Silicon bronze wire, 3,899 pounds	699.24	
Wire staples, 1,610 pounds	39.78	
5/16-inch clips, 6,074	406.15	
⅜-inch clips, 1,337	105.10	
½-inch clips, 3,520	291.34	
Rope	793.69	
Lumber	65.72	
Ferriage of laborers from Memphis to works	655.91	
Labor, including subsistence	23,654.53	
Total cost at $6.045 per square		$59,160.01
Sixteen connecting mats, containing 1,342.46 squares:		
Brush, 1,906.77 cords	$2,059.33	
Poles, 122.89 cords	245.78	
Stone riprap, 1,012.81 cubic yards	1,711.65	
¼-inch wire strand, 9,059 pounds	310.42	
5/16-inch wire strand, 4,750 pounds	135.51	
⅜-inch wire strand, 140 pounds	3.32	
½-inch wire strand, 1,835 pounds	59.64	
No. 12 wire, 4,244 pounds	93.40	
Wire staples, 340 pounds	8.34	
5/16-inch clips, 1,546	120.61	
⅜-inch clips, 13	1.04	
½-inch clips, 73	6.22	
Rope	147.00	
Ferriage of laborers from Memphis to works	127.51	
Labor, including subsistence	4,419.02	
Total cost, at $7.038 per square		9,448.79
Four shore mats and 90 linear feet of brush drains, 119.75 squares:		
Brush, 164.60 cords	$177.77	
Poles, 45 cords	90.00	
Stone riprap, 250 cubic yards	422.50	
No. 12 wire, 616 pounds	13.55	
Labor, including subsistence	313.08	
Total cost at $8.50 per square		1,016.90
Total cost of mattress work		69,625.70
Clearing bank, 6.8 acres:		
Labor, including subsistence, at $114.02 per acre		775.36

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Hydraulic grading, 1,120 linear feet, 33,000 square yards:		
Labor, including subsistence	$815.95	
Coal	347.59	
Oil and engineers' supplies	126.83	
Total cost at $1.1521 per linear foot, or $0.0391 per square yard		$1,290.37
Hand grading, 26,342 square yards:		
Labor, including subsistence, at $0.08204 per square yard		2,161.12
Paving bank, 22,665 square yards:		
Stone riprap, 5,319.13 cubic yards	$8,989.33	
Stone spalls, 1,061.01 cubic yards	1,793.12	
Stone spalls (stock), 324 cubic yards	474.04	
Stone riprap, 100 cubic yards	146.00	
Lumber	77.00	
Ferriage of laborers from Memphis to works	180.24	
Labor, including subsistence	4,437.82	
Total cost, at $0.7102 per square yard		16,097.55
Total cost of paving, clearing, and grading		20,324.40
Cost per square yard, $0.8967.		
Repairing old work, 3,265 square yards, including removing and relaying paving, and dressing bank:		
Labor, including subsistence, at $0.318 per square yard		1,038.18
Sinking four barges in holes:		
Stone riprap, 160 cubic yards	$270.40	
No. 12 wire, 300 pounds	6.60	
½-inch strand, 430 pounds	13.98	
½-inch clips, 4	.34	
Labor, including subsistence	429.22	
Total cost, at $180.13 per barge		720.54
Total construction cost		91,708.82
General expenses.		
Superintendence:		
Labor, including subsistence		$4,138.31
Care of plant:		
Labor, including subsistence	$3,662.63	
Coal	324.00	
Oil and miscellaneous material	91.25	
		4,077.88
Repairs to plant:		
Labor, including subsistence		590.39
Towing:		
Labor, including subsistence	$5,063.41	
Coal	3,649.67	
Oil and engineers' supplies	142.10	
Hire of steamers	885.00	
Miscellaneous material	173.05	
		9,913.23
Total of general expenses		18,719.81
Total field cost		110,428.63

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The general expense account is 20.4 per cent of the construction cost. This is much higher than usual, due to long-distance towage, etc., and the cost of caring for plant during the two ice runs.

Additional expenditures were:

Plant repairs at fleet	$553.41
Surveys	944.65
Main office expenses	1,298.75
Property, appliances, outfit, etc	3,566.71
Total	6,363.52
Making the total expenditures	116,792.15

Prorating the general expense account into construction items, the field costs per unit of work are as follows:

	Per square.
Cost of channel mats	$7.278
Cost of connecting mats	8.473
Cost of paving (including clearing and grading)	1.079

The total length of channel mats built was 3,984 feet, but these protected only 3,817 linear feet of bank, the difference, 167 feet, being due to laps and increased lengths of mats over bank measurements on account of curving them into pockets and around points.

The cost of the complete revetment in the gap, from stations 0 to 16 W., a length of 1,600 feet, was $33.234 per linear foot.

The following table shows the quantity of material used per unit of work:

	9,786.73 squares channel mats (per square).	1,842.46 squares connecting mats (per square).	22,665 square yards paving (per square yard).
Brush, cords	1.5112	1.42	
Poles, do	.077	.091	
Stone, cubic yards	.651	.754	.3002
Wire, No. 12, pounds	2.528	8.161	
Wire, bronze, do	.398		
Wire strand:			
½-inch	6.006	6.75	
⅜-inch	3.498	3.54	
¼-inch	.555	.105	
½-inch	3.88	1.367	
Clips, assorted, number	1.12	1.22	

WOLF RIVER.

The dredge *Wolf*, two dump scows, and tender steamer *Itasca* were moved to Wolf River on August 18. Dredging was begun on the following day at the mouth and continued up to the railroad incline until September 26, 18,720 cubic yards of material being removed and a good navigable channel opened. When work was begun the stage was 6.5 feet; it then rose to 7.9 feet on August 31; fell to 3.8 feet September 21, and rose to 6.8 feet on September 26. The dredge was then moved to the shoal below Bayou Gayoso and worked there until October 5, the stage being between 6 and 7 feet. Then three days' work was done at Cochran's incline, and from October 10 to 31 the shoal below the Anderson-Tully mill was dredged. Here the dredging was hard, much of the material being coarse sand mixed with gravel, shattered rock, and bowlders, the result of the blasting operations here in 1902.

The river at this time had fallen to the 3-foot stage, developing some shoal places below the railroad incline, whither the dredge was moved and operated until November 9, when the river had risen to the 5-foot stage. From November 10 to 18 a second cut was made through the Bayou Gayoso shoal, after which work was resumed on the Anderson-Tully shoal, and continued there until December 7, the water falling to the 2.5-foot stage.

One day was spent in dredging and removing snags just above the railroad bridge to open the channel to Bennett's mill. This was the only work done above the bridge, as the other mills there were idle for other than shoal channel causes. From December 8 to 10 a small shoal was removed below the railroad incline. This improved the channel so that the transfer boat carried full loads

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for the balance of the season, although the river fell to the 0.6-foot stage December 26.

From December 11 to 22 work was continued and finished on the Anderson-Tully shoal; the broken stone and bowlders were dredged from the channel and the rock cut widened by blasting, about six days being consumed in the latter work, using 150 pounds of dynamite in charges varying from 3½ to 19½ pounds; about 340 cubic yards of this rock was removed with the dredge.

On December 23 the dredge was worked at Bayou Gayoso. A heavy rain that night made the current too strong for work the next day; this, quickly followed by more rain, caused a strong run-out in Wolf River, and, as the Mississippi began to rise, work was suspended for the season and the plant cleaned up and crew discharged December 31.

Navigation was maintained during the entire season up to the railroad bridge, although the water fell below the 1-foot stage. The dredging this season has put the river in much better condition than ever before at such a low stage, and the work done on the rock ledge will make a permanent improvement there.

The following work was done at localities named:

Between the mouth and the railroad incline: 24,560 cubic yards material, 10 saw logs, 1 snag, 1 set car trucks.

Shoal below Bayou Gayoso: 9,000 cubic yards material, 13 saw logs, 3 snags, 1 stump, 1 section railroad iron.

Shoal at Cochran's mill incline: 1,440 cubic yards material, 2 saw logs.

Shoal below Anderson-Tully mill: 12,200 cubic yards material (of which 340 cubic yards was rock), 120 saw logs, 8 snags, 2 stumps.

Between the railroad bridge and Bennett's upper mill: 240 cubic yards material, 3 saw logs, 1 snag.

Total work done: 47,440 cubic yards of material dredged, 166 obstructions removed.

All material and many obstructions were dumped into the Mississippi River, and some of the saw logs turned over to mill owners.

The field cost was as follows:

For operating dredge:		
Labor	$2,212.68	
Fuel	811.10	
Machinery repairs and material	179.82	
Oil and engineer's supplies	76.09	
Explosives	27.91	
Ice	17.00	
		$3,324.60
For operating tender boat:		
Labor	1,485.67	
Fuel	503.60	
Repairs, material, and supplies	37.87	
Oil and engineer's supplies	27.60	
Ice	14.60	
Hire of steamer	495.00	
		2,564.34
Superintendence		250.00
Total field cost		6,138.94

Distributed as follows:

Dredging 47,440 cubic yards, at $0.1115	$5,289.43
Removing 166 snags, at $2.945	488.87
Blasting 340 cubic yards rock, at $1.060	360.64
	6,138.94

The total expenditures for the year ending March 31, 1905, were:

Field cost as above	$6,138.94
Main office expenses	408.07
Care of plant during lay-up period	350.00
Repairs to floating plant (including $321.53 for new dipper and fixtures)	1,748.34
Property purchased	31.53
Total	8,676.88

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On the basis of total expenditures the unit cost is:

Dredging, per cubic yard	$0.158
Snagging, per snag	4.122
Blasting, per cubic yard	1.484

Commercial statistics of Wolf River for the year 1903.

Number of lumber manufacturing plants, 8.	
Capital invested	$1,565,000
Value of finished product	$2,442,000
Paid in wages	$562,500
Timber sawed ---------- Feet B. M.	80,400,000
Value in logs	$707,250
Lumber purchased on barges ---------- Feet B. M.	15,200,000
Value at mill	$286,000

Towing plant employed: Steamers, 8; derrick boats, 2; barges, 12; total value, $130,000.

Freight cars transferred by Choctaw, Oklahoma and Gulf Railroad Company steamer *Gen. Pierson*, 32,400.

Respectfully submitted.

W. M. REES,
Assistant Engineer.

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

APPENDIX 2 C.

REPORT OF MR. A. J. NOLTY, UNITED STATES ASSISTANT ENGINEER, ON PLANT PARTY, AT MEMPHIS, TENN., DURING SEASON OF 1904–5.

MEMPHIS, TENN., *May 1, 1905.*

CAPTAIN: I have the honor to submit my annual report of the care of and repairs to plant party at Memphis, Tenn., for the season of 1904–5.

Steamer Chisca.—Very little work was done on this vessel in 1904. The work done then consisted in making new plungers for the "doctor," screening doors, windows, and transoms, and a general overhauling of the machinery. Since the boat was laid up after the close of construction work new stacks were erected, breeching repaired, engines overhauled, wheel repaired, boat painted inside and out, joiner work in front of pilot house taken down and reset in order to close up shrinkage openings, and two new sheets put into boilers. The entire roof was newly covered with 12-ounce army duck. This vessel is in good condition.

Steamer Titan.—A hot-water boiler was attached to the cooking range and connection made with the bathroom and washstands; all doors, windows, and transoms were screened; a large ice chest was built on the main deck and a refrigerator set up on the boiler deck aft of the cabin; main engines were lined up, and new cams were attached to wheel shaft and new cam and bracket made and put up on port cylinder timber to replace a broken one; capstan engine was repaired, furnace rebuilt, and one new mud drum attached to boiler to replace one so badly corroded as to make its further use dangerous. The wheel has been partially rebuilt and reduced in diameter 12 inches, as it dipped 6 inches too deep. Fantail on port side was renewed, the old one having been crushed in by collision with one of the dredges working in Presidents Island Crossing. The boat is now being painted on the outside. A steam steering machine is being built in the fleet shop at such times when the machinist has no more urgent work to do. Present condition of boat good. This vessel was last fall backed upon the wreck of the *James Lee* and had a hole stove in the bottom just forward of the rake. This has been well battened from the inside, making it perfectly secure. It can not be better repaired until the boat is placed on the ways for other repairs.

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Steamer Graham.—This vessel has received only minor repairs to machinery and hull. All steam pipes were covered with magnesia covering. The boat will be painted soon. Present condition good.

Steamer Abbot.—This vessel has had both cylinders bored out, as they were worn out of true. The feed-water heater is being thoroughly repaired, it requiring new water tubes, tube sheet, and bottom head. Engines are being lined up and put in good condition. The vessel will be docked soon in order to have some slight repairs made to hull under the boiler, after which the condition of the boat will be good.

Steamer Unique.—This vessel is a single-screw propeller with triple-expansion engines and a Ward water-tube boiler. The hull is of steel; length, 90 feet; beam, 13.5 feet; depth of hold, 5 feet; draft, 32 inches; engines are 7 inches, 10.5 inches, 16 by 10 inch stroke; boiler pressure allowed, 225 pounds; gross tonnage, 33. The boat was built at Charleston, W. Va., in 1901, but had been little used before purchase by the United States. The boat is well adapted for inspection trips and for survey duty, but is too light in structure for heavy towing. The speed as calculated from a number of trips is equivalent to about 11.5 miles in still water. Upon arrival of the boat at the fleet the old paint on the outside of cabin was burnt off and four coats of white lead in oil applied. A water-closet for the crew was fitted up in the forward hold; two ventilators were put over the engine room to carry off the hot air; an asbestos shield was hung in front of the boiler to reduce the heat in the engine room; a reflex water gauge was put in in place of the ordinary one, which would not stand the pressure, and a steam fan was set up in the cabin. Some changes were made in the vestibule or entrance to the saloon; cupboards for the china and silverware made; lockers provided for each berth in the stateroom, etc. On one of the trips the cylinder head and piston head of the low-pressure cylinder were broken. The damage was repaired by the purchase of new parts. The vessel was docked for examination of bottom, which was found in good condition, except at places where the brass fittings of the outboard condenser pipes touched the steel skin. Here the action of the electrolysis was very apparent in the deep pittings. The bottom was scraped and painted with red lead and the brass insulated from the steel. Some of the tubes of the boiler were opened for the purpose of ascertaining the condition of the interior, and they were found to be perfectly clean on the inside, showing no scale or other deposit. The boat is very complete in every respect, being fitted out with dynamo, searchlight, incandescent lights all over, bath tubs, water-closets, washstands, hot and cold water, circulating pumps, condenser, spare propeller, life-preservers, lifeboat, etc. Present condition good.

Tug Itasca.—Two new sheets and one new mud drum were put into the boiler; new pistons in cylinders; wheel repaired; boat docked, scraped, and painted. Present condition good.

Grader No. 2.—One new water chamber put in to replace a badly cracked one; and general repairs of a minor nature to put in shape for the season's work. Present condition good.

Grader No. 9313.—The hull for this machine was built out of barge *No. 9313* the previous season. During the present season the machinery from former grader *No. 40*, the hull of which had been condemned as not worthy of repair, was moved onto the new hull and erected. Two boilers from condemned grader *No. 4* were set up. On one end of the hull pile-driver leads were erected and a suitable engine placed. A donkey boiler and pump for washing out the main boilers has been set up, the boiler having been transferred from the dredging fleet. Present condition of this machine good, except that some work will have to be done to the friction hoist of the pile-driver machinery, which does not hold well.

Machine shop.—Received only routine repairs, such as patching guards, lining up shafting, repairs to engine, including the boring out of the cylinder, repairs to machine tools, etc. This boat should be docked this season for repairs to hull. Present condition only fair.

Pile driver No. 6.—Minor repairs of small extent only. Present condition good.

Pile driver No. 9.—Minor repairs sufficient to keep hull afloat. This machine should be docked, as the hull is in unseaworthy condition. Present condition of hull bad.

Dredge Wolf.—This machine was docked in order to have some damage to head block below the water line repaired. The machinery was overhauled and everything put in shape for the season's dredging operations in Wolf River.

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The dredge was again docked February 20, 1905, to have hull rebuilt. This work is about completed, and as soon as the vessel comes off dock the machinery and rigging will be put into thorough shape. Its condition then will be good.

Barges (built in 1893).—*Nos. 9303, 9305, 9317, 9319, 9320, 9323,* and *9327* were rebuilt from the bottom up during the season, making practically new barges of them. *No. 9317* was changed into an open-hull coal barge. In addition to the above, *9318,* rebuilt all but the deck during 1903, had the deck placed. These barges are all in good condition, except that two of them were slightly damaged below the water line while working in the third district, and will have to be docked. Barges *9306, 9315, 9325, 9326,* and *9329* were calked while afloat. Present condition good. Barge *9303,* having struck a snag while towing brush for the Hopefield Bend work, was docked in December, when it was found that the entire rake, collision bulkhead, and part of the contiguous bottom were broken. It was repaired, and the barge is again in good condition.

Barges, model (built in 1894).—*Nos. 9407* and *9408* were rebuilt in 1902 and are in good condition. *Nos. 9406* and *9409* were rebuilt in 1903, and at the same time changed into square-ended mooring barges. They are in good condition. These four barges received only minor repairs during the season. *No. 9410* was patched and changed into a fascine barge. It was so badly damaged at the close of the working season in the third district by running ice that it sank, and, as it was not worth recovering, it was dropped by affidavit.

Nos. 9401, 9402, 9403, 9404, and *9405* are entirely unseaworthy and not worthy of repair.

Third district barges *Nos. 568, 572, 587,* and *589* were loaned to the first and second districts for the season. *No. 568* was in a leaky condition when received, and had to be docked when it was found that the lower gunwale strake was crushed in and broken. This was repaired. *No. 589* sprung a leak while in service and had to be docked for calking. These barges were returned to Greenville, Miss., toward the close of the working season.

Mooring barges *Nos. 1* and *2* were calked and had some other minor repairs done to them. Present condition good.

Mattress barges *5, 6, 9308,* and *9312* were calked and received necessary repairs to decks, ways, and appliances used in mat construction. Present condition good.

Quarter boats.—*Amelia,* rebuilt from bottom up, cabin and roof painted, cooking range repaired. Present condition good.

No. 12 received only such repairs as were necessary to prevent its loss. It was not in service during the season and it should be rebuilt this season. Present condition very poor, but worthy of repair.

No. 25 was made serviceable for the season's work by being calked and patched while afloat. Should be docked this season for extensive repairs. Present condition poor.

No. 27 was rebuilt from the bottom up, was painted, had some changes made in the office part of the boat, and had roof repaired and painted. Present condition good.

Nos. 206 and *221* calked while afloat; roof painted. Present condition good.

No. 8 (store boat) partially rebuilt and put into condition to hold all the heavy stuff stored in *No. 26,* which latter boat was becoming unsafe. Present condition of *No. 8* good.

All the quarter boats had doors and windows screened and cooking ranges repaired. *Nos. 206* and *221* also had shutter ventilators put over each window, so as to ventilate the dormitories.

Quarter boat No. 39.—This is attached to the survey party. It received no repairs and its present condition is good.

No. 26.—This has been used until lately as a store boat for heavy stores and property, but it has become so unseaworthy that nearly everything has been removed onto *No. 8.* This boat has a good cabin and its hull is worthy of repair.

Mississippi.—This is a small quarter boat. It is entirely unseaworthy, and as there will probably be little, if any, need for it, and as it is hardly worth repairing, it is recommended for condemnation.

No. 9309.—This boat has a cheap cabin upon it, and has been used mainly as a blacksmith and carpenter shop in the field, or when there was more work at the fleet than the regular shop could do. It is proposed to take down the cabin and rebuild the hull as one of the six new barges, recommended further on.

Flats.—These are practically small barges, one being 60 feet long by 16 feet wide and the others 50 by 15 feet. There are now four of these, *No. 4*

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having been built for the survey party during the past season. The other three were calked and received slight repairs. Present condition of all good.

Miscellaneous work.—The usual work of repairing skiffs, tools, and appliances; washing blankets; making coal boxes, capstan bars, pike poles, wire twisters, staple hammers and cable clamps; repair to wheelbarrows, etc., has been done. The floating plant has at all times been properly cared for by the small force of watchmen, pumpers, and roustabouts, made up, during the periods when no field work was in progress, of the foremen from the construction parties. During the season of field work the places of these men are temporarily filled by ordinary laborers. All the machinery heretofore stored in the warehouse at Luxora, Ark., and on the bank of Elmot bar, was condemned and ordered sold at public auction, which was done on January 3 and March 10 of the current year. Some engines, boilers, and pumps were shipped to Lieutenant-Colonel Stanton, Boston Harbor, and to Major Langfitt, at Portland, Oreg., during the summer. Two Copeland & Bacon hoisting engines and one horizontal engine have been retained for use here. It is proposed to use the two former in some device for storing stone, while the latter would make an excellent shop engine, should the need for an additional shop arise.

The plant has been increased during the year by the purchase of one steamer and six skiffs and by the building of one additional flat. It has been reduced by the dropping, by affidavit, of three barges and by the condemnation of barges *9302*, *9314*, *9316*, and *227*. The floating plant is in better shape now than it has been for a number of years. If the project as hereinafter outlined is carried out we will have a full and complete outfit for two construction parties, and the cost of maintenance will be comparatively small for several years to come.

Itemized statement of the cost of, care of, and repairs to plant.

First and second district plant:

Care of plant	$11,951.07
Steamer *Chisca*	2,242.64
Steamer *Titan*	1,233.94
Steamer *Graham*	730.71
Steamer *Unique*	[a] 8,923.75
Steamer *Abbot*	75.45
Steamer *Itasca*	861.35
Barge *No. 9306*	20.20
Barge *No. 9310*	17.65
Barge *No. 9317*	2,379.15
Barge *No. 9319*	2,448.93
Barge *No. 9323*	2,617.39
Barge *No. 9326*	7.25
Barge *No. 9329*	19.00
Barge *No. 9407*	68.34
Barge *No. 9410*	690.21
Mooring barge *No. 2*	36.40
Mooring barge *No. 9406*	24.35
Mattress barge *No. 6*	38.40
Mattress barge *No. 9312*	75.50
Quarter boat *No. 12*	11.35
Quarter boat *No. 27*	1,480.56
Quarter boat *No. 221*	76.57
Quarter boat *No. 11*	30.00
50-foot flat (new)	495.50
Miscellaneous work	809.77
Purchase of tools and appliances	1,030.33
Grader *No. 2*	1,590.37
Grader *No. 9313*	1,769.51
Pile driver *No. 6*	24.24
Pile driver *No. 9*	14.80
Machine shop	761.15
Dredge *Wolf*	2,160.97
Barge *No. 9303*	2,672.48
Barge *No. 9305*	2,691.29
Barge *No. 9315*	18.40

[a] Includes $7,000, one-half of purchase price.

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First and second district plant—Continued.		
Barge *No. 9318*	$745.27	
Barge *No. 9320*	2,292.06	
Barge *No. 9325*	7.50	
Barge *No. 9327*	2,104.28	
Barge *No. 9405*	7.70	
Barge *No. 9408*	882.80	
Mooring barge *No. 1*	47.70	
Mooring barge *No. 9409*	17.15	
Mattress barge *No. 5*	38.40	
Mattress barge *No. 9308*	58.75	
Quarter boat *Amelia*	1,154.99	
Quarter boat *No. 25*	132.80	
Quarter boat *No. 206*	61.75	
Quarter boat *No. 8*	1,191.68	
Flats and skiffs	140.44	
Dump scows	115.54	
Towing account plant	1,135.67	
Total		$59,746.45
Third district plant:		
Barge *No. 568*	115.85	
Barge *No. 587*	14.80	
Barge *No. 572*	14.80	
Barge *No. 589*	466.97	
Total		612.42
Grand total		60,743.45
Deduct repairs to dredge *Wolf* (paid for out of Wolf River allotment)	2,160.97	
Deduct repairs to dump scows (paid for out of Wolf River allotment)	115.54	
Deduct cost of 50-foot flat (paid for out of levee allotment)	495.50	
Total		2,772.01
Leaving chargeable to allotment for plant, first and second districts		57,971.44

Project.—The following project for repairs to old and for building new plant is respectfully submitted for your consideration:

During the past several seasons the want of one additional mat barge for each construction party has been strongly felt. With our present mat plant as soon as a channel mat has been sunk the mat barges have to be used to construct any connecting mats that might have been required inside the main mat just sunk. If these connecting mats are not built immediately after sinking of channel mats, grading and paving will be delayed. On the other hand, with the present lack of mat barges, if the connecting mats are at once built the work on the next river mat is delayed, and this delay sometimes becomes a serious matter, for it may expose the river-mat construction to a rise, with its attendant run of drift, or, perhaps, to a run of ice, whereas if no delays had occurred the mat work might have been completed before these adverse conditions arose.

It is always desirable to push the channel mats to completion as rapidly as possible, as this is the only class of work constituting the revetment which can be seriously and adversely affected by increased velocity of current, higher stage, or run of drift or ice.

If it is desired to continue the storage of stone on the bank some method other than the primitive one of wheeling should be used for handling the stone. A cableway was installed at Fletchers Bend in 1896, constructed of such machinery and materials as were on hand, and this worked well and economically. The machinery, however, was too light for the work and was by the end of the season pretty well worn out. With some modifications, such a cableway could be made to both unload from barges and reload upon them.

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However, as it is not very portable, it could not be used to advantage in distributing stone along the graded bank for the paving gang.

A floating derrick boat could be constructed that would unload stone upon the revetted bank, reload it from thence upon barges, and also distribute it for the pavers to use.

At a recent auction sale of machinery two single-drum single-cylinder Copeland & Bacon hoisting engines were reserved, and these can be used on either the derrick or the cableway. For the former purpose the two engines should be connected to form a double-drum two-cylinder hoisting engine. A third drum could be fitted so that there would be one drum for the main hoist, one for the boom hoist, and a smaller one for swinging the derrick; or for the latter purpose we could use a detached and smaller engine, of which we have one at the fleet.

The hull for a derrick boat can be built here. It should be about 70 feet long 28 to 30 feet wide, and not less than 4½ feet deep. It should be strongly built with two transverse and two longitudinal bulkheads and with heavy beams under the engine, boiler, and derrick foundation. Mast should be about 40 feet high, held by two stiff legs, and the boom should be not less than 70 feet long.

There should be 6 additional material barges. We could get along with a less number, but if the funds would permit the building of 6 it should be done. We have now 21 serviceable barges, but 3 of these, rebuilt in 1898–99, are no longer safe to carry stone. With the addition of 6 there would be 12 good barges to each construction party, leaving the 3 older ones to be used as landing or plunder barges.

Quarter boat *No. 12* should be rebuilt, as it is now in such condition that it is barely kept afloat. Quarter boat *No. 25* will require docking for repairs. Pile driver *No. 9*, belonging to the St. Louis works, is in very bad condition and should be docked and made safe if nothing more. Store boat *No. 6* had to be almost completely unloaded in order to prevent loss of boat and property. It should be rebuilt, and as we are crowded for shop room I would recommend its use as a carpenter and pipe-fitting shop and storeroom for the large number of patterns now scattered about on various boats.

The present shop boat will require docking for repairs to hull. Office boat *Mississippi* is in very bad condition and hardly worth repairing. As we will have but little use for this boat, I recommend that it be condemned.

Summary of project.

Hull for derrick boat	$2,000	
Derrick with boom, stiff legs, bull wheel, etc	1,200	
Fitting up engines, including all necessary changes	600	
One 50-horsepower plain cylindrical-flue boiler	500	
Setting up engines and boiler, including foundations	300	
Building furnace and making steam connections	300	
Miscellaneous work, including shed over machinery	500	
Two mattress barges, at $3,500	7,000	
Six material barges, at $2,800	16,800	
		$29,200
Repairs to quarter boat *No. 12*	1,800	
Repairs to quarter boat *No. 25*	1,200	
Repairs to store boat *No. 26*	2,000	
Repairs to shop boat	1,500	
Repairs to pile driver *No. 9*	800	
Improvising 4 fascine barges from unserviceable plant	2,000	
Calking plant ready for field work	900	
Miscellaneous and contingencies	2,000	
		12,200
Care of plant, 12 months, at $1,500		18,000
Total		59,400
Or, with only 3 new material barges		51,000

Respectfully submitted.

AUG. J. NOLTY,
Assistant Engineer.

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

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APPENDIX 2 D.

REPORT OF MR. D. M. BROCK, UNITED STATES JUNIOR ENGINEER, ON LEVEES, UPPER ST. FRANCIS AND REELFOOT LEVEE DISTRICTS, FOR SEASON OF 1904–5.

MEMPHIS, TENN., *May, 1, 1905.*

CAPTAIN: I have the honor to submit the following report of operations in the upper St. Francis and Reelfoot levee districts during the season of 1904–5.

PART I.—UPPER ST. FRANCIS LEVEE DISTRICT.

This levee district at present extends from Birds Point, Mo., opposite Cairo, Ill., to New Madrid, Mo. (70 miles below Cairo, Ill.). The length of levee when completed will be about 66 miles and will protect an area of about 700 square miles.

Two local levee boards are in this district, the Mississippi County levee district No. 1 for levees located in Mississippi County, Mo., and the St. John levee district No. 1 for levees located in New Madrid County, Mo., the latter having been very recently organized, and expecting to be prepared to begin levee construction during the fiscal year 1905–6.

At the beginning of the year there remained to be completed one 1903–4 contract, stations 5/20 to 6/0 (6 R.), Shutt Improvement Company, contractors. This work was completed August 22, 1904, 8,259.5 cubic yards being placed this season. Total yardage in contract, 98,259.5 cubic yards, at a cost of $19,160.60, an average of 19.5 cents per cubic yard, not including engineering and office expenses.

From the allotment of $15,000, made from the appropriation for the year 1904–5, levee was constructed from stations 13/28 to 15/38, containing 95,436.4 cubic yards, under contract with Ben Talley & Co., at a cost of $10,879.75, an average cost of 11.4 cents per cubic yard, not including engineering expenses. This contract was completed August 16, 1904.

In addition to the above, from the allotment of $25,000 made from the appropriation for the year 1905–6, a contract was entered into with the Talley-Bates Construction Company, for levee, to be paid for July 1, 1905, from stations 9/8 to 10/23 and 10/28 to 13/28, the yardage being 195,470.7 cubic yards, at a cost of $23,925.61, an average cost of 12.24 cents per cubic yard, not including engineering expenses. This contract was completed March 30, 1905.

In addition to the work done by the United States during this year the Mississippi County levee district No. 1 has constructed levee as follows:

Stations.	Cubic yards.	Cost.
8/16 to 9/8	29,212.9	$3,330.27
15/38 to 16/10	98,422.1	11,220.12
16/28 to 18/44	56,186.9	6,590.72
25/44 to 26/36	3,792.7	720.61
5/20 to 5/38		
Total	187,614.6	21,861.72

This work has been done in accordance with the United States specifications for levee work and under the supervision of the engineer officer in charge of first and second districts, Mississippi River improvement.

During the year 20,000 cubic yards of earth has been added by landowners to the levee back of Wolf Island, stations 18/44 to 25/44.

From May 1, 1904, to April 30, 1905, earth has been added to the levee as follows:

	Cubic yards.
By the United States	299,166.6
By the levee board	187,614.6
By landowners	20,000.0
Total	506,781.2

No levee line has been abandoned during the year from caving banks or from any other cause.

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The following is a summary of earth in the levees in this district:

	Cubic yards.
Put up by the United States and in place April 30, 1904	377,198.0
Added by the United States from May 1, 1904, to April 30, 1905	299,166.6
Total	676,364.6
Put up by levee board and landowners and in place April 30, 1904	283,804.0
Added by levee board and land owners from May 1, 1904, to April 30, 1905	207,614.6
Total	491,418.6
Levee in place April 30, 1905:	
Erected by the United States	676,364.6
Erected by levee board and landowners	491,418.6
Total in place	1,167,783.2

During the year the United States put up 299,166.6 cubic yards of earth, at a cost of $36,416.96, including work to be paid for July 1, 1905, making the average construction price 12.17 cents per cubic yard, not including engineering expenses.

During this season the culvert for draining Brewers Lake at station 5/31 (6 R.), begun December 15, 1903, has been completed. (For full description of culvert see Annual Report of Chief of Engineers, 1904, Supplement, p. 192.)

After completion of culvert it was deemed advisable to place an arrangement for raising and closing flap valves. This arrangement consists of a 7-inch I beam placed on top of wing wall 4 feet in front of discharge pipe, reenforced with a 5-inch I beam riveted to center of 7-inch beam and extending at right angles back to center of wing wall. These beams are anchored by being embedded in cement in wing wall. A wire rope is attached to each flap valve, runs through a pulley riveted to I beam, and thence to a double hand winch anchored in top of levee. This culvert was built by the Mississippi County levee district No. 1 in accordance with plans and specifications furnished by this office.

The total cost of culvert was $8,712.38, a detailed statement of which is as follows:

Advertising	$120.59
Telegrams and telephone messages	152.06
Traveling expenses	218.23
Freight on material used	19.10
Team hire	119.56
Supplies for subsisting men	190.08
Boarding men	37.25
Lumber used for forms	81.05
Corrugated steel bars	332.88
Outlet pipes and valves	400.00
Cement	289.00
Piling for foundation	104.50
Miscellaneous material	104.94
Hauling sand, gravel, tools, etc	750.20
Stone for revetting inlet and outlet ditches	897.48
Cutting inlet and outlet ditches	646.97
Revetting inlet and outlet ditches	172.00
Ditching for construction	696.00
Labor on construction	3,380.49
Total	8,712.38

General remarks.—The levee from Birds Point to station 6/0 is in fairly good condition, there being a good stand of sod on the greater part of it. As yet no effort has been made on the part of the levee board to have houses moved off of right of way, and there still exist some fences across the levee. The levee from stations 8/16 to 18/44, though not continuous, is all new work and in good condition, except that the Bermuda sod has not yet gotten a good start at

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spreading. The levee from stations 18/44 to 25/44 has been erected by landowners, and in most places is of insufficient cross section and is generally low. This levee has never been sodded with Bermuda sod and is mostly covered with undergrowth, small trees, and weeds. As yet there have never been any provisions made in this district for cutting weeds, yet in some localities the landowners have cut the weeds on levee located in their immediate vicinity. I recommend that during the season of 1905–6 some provision be made for cutting weeds in this district, in order that the sod may be given a better opportunity to grow and spread.

At present there are three gaps in the levee from Birds Point to foot of Wolf Island, stations 6/0 to 8/16, 10/23 to 10/28, and 16/10 to 16/23. I deem it advisable to have these gaps closed just as soon as the necessary funds are available.

PART II.—REELFOOT LEVEE DISTRICT.

This district extends from the bluffs at Hickman, Ky., 35 miles below Cairo, Ill., to the high land near Slough Landing, Tenn., 59 miles below Cairo, Ill. The length of levee line when completed will be about 23 miles, and will protect an area of about 310 square miles.

Two local levee boards are in this district, the Fulton County levee district for levees located in Fulton County, Ky., and the Lake County levee district for levees located in Lake County, Tenn.

From the allotment of $15,000 made from the appropriation for the year of 1904–5 levee was constructed under contract with Denison & Shafer from stations 5/33 to 7/0 and 8/15 to 8/45, the yardage being 119,924.2 cubic yards; total cost, $13,167.68, an average of 10.98 cents per cubic yard, not including engineering expenses. This contract was completed September 28, 1904.

In addition to the above, from the allotment of $15,000 made from the appropriation for the year 1905–6 a contract was entered into with the Talley-Bates Construction Company for levee work, to be paid for July 1, 1905, stations 7/0 to 8/15 and 8/45 to 9/30, the yardage being 98,545.9 cubic yards, at a cost of $12,801.11, an average of 12.98 cents per cubic yard, not including engineering expenses. This contract was completed March 8, 1905.

Also, from this allotment for the year 1905–6 the United States entered into a contract with Denison & Shafer to fill the gap from stations 5/25 to 5/32, caused by break in the levee during the high water of April, 1904. The amount of yardage necessary to repair this break was 11,159.5 cubic yards, at a cost of $1,841.32, an average of 16.50 cents per cubic yard. This contract was completed December 21, 1904, and is to be paid for July 1, 1905.

All new work during this season from stations 5/33 to 9/30 was built to an elevation 2 feet below the established Mississippi River Commission grade, with 1 foot topping, making the net grade 1 foot below that grade.

In addition to work done by the United States, the Lake County levee board added 50,000 cubic yards of earth to the levee during the season. This was repair work, and was done under the direction of an engineer employed by the levee board.

In the Fulton County levee district no work was done by the levee board during this season.

From May 1, 1904, to April 30, 1905, earth has been added to the levee in the Reelfoot levee district as follows:

	Cubic yards.
By the United States	229,629.6
By the levee board	50,000.0
Total	279,629.6

No levee has been abandoned during the year from caving banks or from any other cause.

The following is a summary of earth in the levee in this district:

	Cubic yards.
Put up by the United States and in place April 30, 1904	253,361.0
Added from May 1, 1904, to April 30, 1905	229,629.6
Total	482,990.6

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	Cubic yards.
Put up by local levee board and in place April 30, 1904	535,770.0
Added from May 1, 1904, to April 30, 1905	50,000.0
Total	585,770.0

Levee in place April 30, 1905:

Erected by the United States	482,990.6
Erected by local levee boards	585,770.0
Total in place	1,068,760.6

During the year the United States put up 229,629.6 cubic yards of earth at a cost of $27,801.11, including that amount which is to be paid July 1, 1905, the average construction price being 12.11 cents per cubic yard, not including engineering and office expenses.

General remarks.—All levees built in this district are in good condition, with the exception that from the bluff at Hickman, Ky., to station 5/25 there is a poor stand of Bermuda sod, and weeds are very thick on this part of the levee. I recommend that during the fiscal year 1905–6 provision be made for resodding this levee and cutting the weeds, in order that the sod may have a better opportunity to grow and spread.

In the Fulton County levee district the fences upon the levee have never been removed, but in the Lake County levee district the levee is clear of all obstructions. No riding or driving upon the levee has been reported in either district.

At no place in the district is the levee threatened by caving banks. There yet remains a gap of about 7¼ miles to be completed in this district, the closing of which will take at least four years' allotment.

Respectfully submitted.

D. M. BROCK, *Junior Engineer.*

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

APPENDIX 2 E.

REPORT OF MR. M. GARDNER, UNITED STATES ASSISTANT ENGINEER ON LEVEES, LOWER ST. FRANCIS, UPPER YAZOO, AND WHITE RIVER LEVEE DISTRICTS, FOR SEASON OF 1904–5.

MEMPHIS, TENN., *May 1, 1905.*

CAPTAIN: I have the honor to submit the following report of operations in the lower St. Francis, Upper Yazoo, and White River levee districts for the year ending April 30, 1905:

PART I.—LOWER ST. FRANCIS LEVEE DISTRICT.

This district extends from the highlands about 9 miles below New Madrid, Mo. (79 R.), to near the mouth of the St. Francis River in Arkansas (298 R.), and has about 210 miles of levee. The area protected is about 3,500 square miles. (For further description see Report of the Chief of Engineers for 1902, Supplement, p. 95.)

At the beginning of the year there were still in force one of the 1902–3 and two of the 1903–4 contracts, as follows:

Location.	Miles below Cairo.	Cubic yards.	Cost.	Remarks.
11/0 to 15/0	92 R.	18,000.0	$2,700.00	1902–3
15/0 to 17/0	95 R.	8,945.7	1,520.77	1903–4
127/28 to 134/0	213 R.	178,866.7	30,300.02	1903–4

All the above contracts have been completed.

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The following contracts were entered into to be paid for out of the 1904–5 allotment:

Location.	Miles below Cairo.	Cubic yards.	Price per cubic yard.	Cost.
			Cents.	
Point Pleasant	80 R.	97,155.9	13.25	$12,873.16
54/11–55/30	140 R.	137,298.5	13.75	18,878.27
65/18–69/0	151–154 R.	124,112.5	17.00	21,099.12
69/0–72/0	154–157 R.	75,561.2	17.45	13,185.43
104/0–108/0	191–195 R.	161,680.0	16.45	26,588.13
108/22–112/42	196 R.	79,838.8	16.50	13,172.49
116/0–117/28	200 R.	135,514.0	16.45	22,292.06
134/0–139/0	218–218 R.	177,298.8	15.74	27,906.04
211/47–214/38 [a]	281 R.	525,508.0	14.90	78,299.94
Total from the two appropriations		1,518,900.2		234,294.64

[a] Also from appropriation for extension and enlargement of Walnut Bend levee, June 13, 1902.

The following contracts were entered into, to be paid for out of the 1905–6 allotment:

Location	Miles below Cairo.	Cubic yards.	Price per cubic yard.	Cost.
			Cents.	
72/0–81/0	165–167 R.	162,273.5	13.00	$21,095.56
96/0–104/0	185–191 R.	169,664.0	14.20	24,092.28
139/0–150/0	217–231 R.	374,758.7	15.74	58,987.02
Total		706,696.2		104,174.86

The local board completed the closure of the 17-mile gap below Scanlan, putting in place 823,059.3 cubic yards, at a cost of $166,265.68.

Total expenditure by the local board from May 1, 1904, to April 30, 1905:

Levee maintenance	$42,481.14
Salaries and per diem	6,385.00
Levee construction	166,265.68
General expenses	3,089.21
Right of way and damages	15,387.53
Interest, discount, and commission	4,219.23
Drainage	166.29
Storage supplies	269.27
Surveys	331.08
Costs	464.90
Levee lands	503.45
Engineers' office supplies	371.22
Salaries of engineers	8,667.57
High-water expenses	902.00
Freight and transportation	392.65
Interest on bonds and certificates	69,000.00
Total	291,463.22

Summary of earth in the levee.

	In place Apr. 30, 1904.	Added during year.	In place Apr. 30, 1905.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*
By the United States	5,234,111	2,411,504	7,645,615
By local board	10,071,861	823,059	10,894,920
Total	15,305,972	3,234,563	18,540,535
Lost or abandoned			150,000
Total			18,390,535

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Caving bank.—There are three places in this district where caving is threatening the levee. At one place, River Styx (140 R.), a new loop was built during the past season. At St. Clair (220 R.) the bank is getting very near the levee, so much so that a new loop is contemplated this season. At Walnut Bend (281 R.) the river is getting dangerously near the levee, and it is probable that revetment will have to be resorted to to save this levee, as the neck between the Mississippi and St. Francis rivers is very narrow here, being only about 1 mile across.

The condition of the levees in this district is far from satisfactory, as they are generally low and almost entirely without banquette. The local board have been exerting all their energy in getting the gap below Memphis closed, which they succeeded in doing during the past season, and as a consequence they did very little enlarging for the past two years.

PART II.—UPPER YAZOO LEVEE DISTRICT.

This district extends from the bluffs just below the Tennessee-Mississippi State line (249 L.) to the Coahoma-Bolivar county line (365 L.), and has 124 miles of levee, which protects 3,281 square miles. (For further description see Report of the Chief of Engineers for 1903, Supplement, p. 178.)

At the beginning of the year there was one 1903–4 contract still in force, the contractor being allowed to move off the work to do more urgent work in the third district. This contract extended from stations 42/16 to 49/13 (280–300 L.), and amounted to 289,568.9 cubic yards, of which 132,256.6 was in place May 1, 1903. The balance, 157,313.3 cubic yards, was put up and contract completed November 18, 1904.

For the money allotted to this district for 1904–5 a contract was entered into with Ben Talley & Co. to construct a new levee from 80/0 to 82/0 (332 L.). This is a cross levee from the front to the back levee, about 3 miles long. It leaves the front line at 80/0 and joins the back one a short distance above the Ward Lake levee.

The necessity for this cross levee arose from inability to hold the end of the front levee and the very treacherous foundation of the Ward Lake line. The gradual washing of the end of the front levee made the high-water surface along the Ward Lake line go higher, which developed the weakness of the foundation there.

For work to be paid for out of the 1905–6 allotment a contract was entered into with George B. Vaughn to build a new levee in the vicinity of Lake Charles to join one at the Coahoma-Bolivar county line under construction by the Mississippi Levee Board.

The necessity for this new work was due to the rapid caving of the river bank in the vicinity and below Australia, Miss., and the impracticability of a loop in the immediate vicinity, so the new levee had to go around Lake Charles, which necessitated this district undertaking that part of it in Coahoma County. As it is intended in this district to maintain the old front levee both at Lake Charles and where the other cross levee is being built (station 80/44), it can not be said that any levee was abandoned during the year. The object of maintaining these levees is to let them act as spurs, thus preventing the water from taking the shorter route across the point and avoid the possibility of the water ponding up at the lower end.

The following is a summary of work done by the United States from May 1, 1904, to April 30, 1905:

Location.	Miles below Cairo.	Cubic yards.	Price per cubic yard.	Cost.
			Cents.	
42/16–49/13	280–300	157,313.3	18.87	$29,695.02
80/44–82/0	332	359,685.8	17.49	62,900.30
121/0–122/8	356	241,685.8	13.74	33,207.63
Total		758,684.9		125,802.95

All of the above contracts are completed.

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The local board built, enlarged, and repaired the following levee:

Location.	Miles below Cairo.	Cubic yards.	Cost.	Remarks.
240-24/24	266 R.	10,000	$1,590.00	Enlargement.
250-290	267 R.	214,000	43,883.90	Do.
42/17-49/18	288 R.	21,430	4,043.84	Supplemental United States.
80/44-82/0	332 R.	97,888	17,110.46	Do.
820-840	332 R.	625,200	144,065.00	New.
108/7-111/0	336 R.	285,500	63,630.72	Enlargement.
111/20-114/32	338-352 R.	141,700	29,963.00	Do.
115/18-116/0	353 R.	30,800	5,690.00	Do.
1200-121/12	357 R.	50,357	11,522.17	Do.
121/0-122/8	358 R.	71,178	9,779.85	Supplemental United States.
Ward Lake levee	337 R.	66,562	13,762.80	Emergency enlargement.
Miles 23-24	359-360 R.	17,325	2,114.00	Protection levee.
Total		1,614,615	345,091.84	

Total expenditure for the year.

Levee maintenance	$91,795.51
Right of way	28,844.24
Engineering	14,362.55
General expenses	7,367.04
Mileage and per diem (for members of levee board)	5,164.88
Cost of earthwork	345,091.84
Grand total	492,626.06

Caving bank.—There is one place in this district where caving bank is threatening the levee, on the Polk front, mile 24, where the local board recently built a protection levee. It is quite probable that a new loop will have to be constructed this season.

The following is a summary of earth in the levee in this district:

	Cubic yards.
Put up by the United States and in place April 30, 1904	6,617,786
Added from May 1, 1904, to April 30, 1905	758,635
Total	7,376,421
Put up by the local board and in place April 30, 1904, after deducting levee abandoned during 1903	15,432,836
Added from May 1, 1904, to April 30, 1905	1,614,615
Total	17,047,451
Levee in place April 30, 1905:	
Put up by the United States	7,376,421
Put up by the levee board	17,047,451
Total	24,423,872

PART III.—WHITE RIVER LEVEE DISTRICT.

This district extends from Helena, Ark. (306 R.), to near the mouth of White River (385 R.). It is 74 miles long, of which the United States controls 67 miles. The remaining 7 miles is a private levee known as the Laconia Circle levee, and is maintained by the Laconia levee board.

There is still open in this district four breaks caused by the 1897 high water, aggregating 10,000 feet in length. The area to be protected by this levee when completed is about 910 square miles.

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At the beginning of this year there were no contracts in force. For the 1904–5 allotment of $70,000 the following contracts were entered into:

Location.	Miles below Cairo.	Cubic yards.	Price per cubic yard.	Remarks.
			Cents.	
38/35–45/0	344–362 R.	220,000	17.40	Not completed.
47/48–48/30	363 R.	130,000	14.00	Do.
Total		350,000		

Both of the above contracts are still in force, the contractors being unable to complete on account of bad weather.

The following table shows the cubic yards in place and to be placed on the above contracts:

Location.	In place.	To be placed.
	Cubic yards.	*Cubic yards.*
38/35–45/0	170,091.7	49,908.3
47/48–48/30	64,126.1	65,873.9
Total	234,217.8	115,782.2

In addition to the above work there has been some topping and repairing wave wash at the following stations: 34/46 to 35/52, 49/0 to 49/18, 56/44 to 56/53, and 59/6 to 59/15, amounting to 15,004.2 cubic yards.

The following contracts were entered into for work to be paid for out of the 1905–6 allotment:

Location.	Miles below Cairo.	Cubic yards.	Price per cubic yard.	Cost.
			Cents.	
2/25+20–2/42+20	308 R.	68,018.7	16.94	$11,522.36
9/47–13/9	316–319 R.	169,956.4	16.10	27,362.97
48/18–50/5	365 R.	67,287.2	14.00	9,420.21
Total		305,262.3		48,305.54

Summary of earth put up and cost by the United States during season:

Location.	Cubic yards.	Cost.
2/25+20–2/42+20	68,018.7	$11,522.36
9/47–13/9	169,956.4	27,362.97
38/35–45/0	170,091.7	29,595.96
47/48–48/30	64,126.1	8,977.65
48/15–50/5	67,287.2	9,420.21
Topping	15,004.2	4,201.18
Total	554,484.3	91,080.33

The local boards enlarged and repaired the following levees: Wave wash repaired in front of Helena; partly completed stations 16/7 to 17/8, and enlarged stations 36/0 to 37/37; amounting to 170,000 cubic yards at a cost of $30,481.64, which includes office and engineering expenses and right of way damages, making an average cost of 17.92 cents per cubic yard.

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Summary of earth in the levee in this district:

	Cubic yards.
Put up by the United States from May 1, 1904, to April 30, 1905	554,484.3
Put up by the local boards from May 1, 1904, to April 30, 1905	170,000.0
Total	724,484.3
Deducting 220,000 cubic yards of levee abandoned on account of caving banks leaves a net gain of	504,484.3
Put up by the United States and in place April 30, 1904	6,678,495.0
Added this year	554,484.3
Total	7,232,979.3
Put up by the levee board and in place April 30, 1904	1,633,220.0
Added this year	170,000.0
Total	1,803,220.0
Levees in place April 30, 1905:	
Erected by the United States	7,232,979.3
Erected by the levee board	1,803,220.0
Total	9,036,199.3

This district is in worse condition than any on the Mississippi River, the greater part of it being of insufficient height and section and generally without banquette. Indeed, many miles of it was only gotten above the 1903 high water by putting on a very narrow and steep topping, which in no way strengthened the section, being placed on the eight-foot crown.

Caving in several points in the district has been steadily going on, necessitating the construction of four pieces of new levee during the past season; these loops constituted the greater part of the work done, so there was but little gain in earth placed in the levee. It is quite likely that during the coming season another very expensive loop will have to be built at Old Town Bend (325 R.).

Respectfully submitted.

M. GARDNER,
Assistant Engineer.

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

APPENDIX 2 F.

REPORT OF MR. L. L. GRIFFITH, UNITED STATES JUNIOR ENGINEER, ON SURVEYS, FIRST AND SECOND DISTRICTS, FOR SEASON OF 1904–5.

MEMPHIS, TENN., *May 1, 1905.*

CAPTAIN: I have the honor to submit the following report of surveys in the first and second districts, Mississippi River improvement, during the season 1904–5.

This work was in charge of Assistant Engineer Charles LeVasseur until August 24, 1904, when he was relieved by me pursuant to General Orders, No. 7, dated Memphis, Tenn., August 10, 1904. This report treats only of the work of organized survey party and does not include surveys for and during construction in the different levee districts by the levee inspectors.

The month of May, 1904, found the survey party employed on a survey in Walnut Bend of the territory lying between the Mississippi and the St. Francis rivers, from Whitehall Landing south to Bledsoe Landing, showing the general topographical and hydrographical features of the country situated betewen the two rivers, after which a hydrographical survey from Malones Landing (356

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L.) to Australia Landing (370 L.) was made during the month of June to show the rate of caving along the Mississippi side of the river, with a view of locating a proposed loop in the vicinity of Lake Charles, Miss. On July 10, 1904, a general survey of the lower St. Francis levee district was begun at Point Pleasant, Mo. (80 R.), to ascertain all the data necessary for a complete record of the levee in this district, and also for the purpose of locating all the caving banks. This survey was completed to Nodena, Ark. (98 R.), and on August 24, 1904, the steamer *H. L. Abbot* and quarter boat *No. 39*, with crew, were turned over to me.

On August 15, 1904, with Surveymen Howe and Riegel and the steamer *Unique*, a detailed survey over the revetment in the vicinity of the season's proposed construction work in Hopefield Bend was made and map of same submitted.

On August 29, 1904, a full party was organized and supplies put aboard the *Abbot* and quarter boat with a view of completing the programme of survey work for the season. This work was prosecuted as shown in the accompanying table, which gives an idea of the location and nature of the survey, approximate amount of work required, the total time and actual number of working days consumed, the distribution of the actual number of days to the different parts of each survey, the maps completed to date, and the cost.

Ignoring the last three surveys made by Junior Engineer L. Y. Kerr with the steamer *Graham*, for which I have insufficient data for comparison, it will be noticed that the total number of days in the field was 154, of which 126 were actual working days; of the latter, 23½ days, or about one-fifth, were spent in recovering permanent reference points. It will also be noticed that in each case requiring a base line, except four, new base lines were established, requiring 9¾ days, or about twice as much as would be required had permanent base lines been established in previous surveys. In the same manner the 22¼ days spent in establishing and recovering ranges could have been reduced one-half had they been properly marked and witnessed. As all the available stone lines, established base lines, and ranges were this season properly marked, witnessed, and recorded it is safe to assume that the actual number of working days may next season be reduced by 38 days, which, at the same cost per day ($47.46) as prevailed this season, would amount to a saving of $1,803.48. This accomplishes the recommendation of Assistant Engineer Charles LeVasseur in the last paragraph of his annual report for 1904.

The methods employed in making these surveys were practically the same as have been in vogue in the third district, a detailed description of which is given in Junior Engineer Kerr's annual report for 1904. (See Report Chief of Engineers, 1904, Supplement, p. 241.)

With the exception of the survey over the revetment in Hopefield Bend and Memphis bar, where it was possible to retrace old base lines, no comparison with past conditions can be shown in the cross sections, and the real value of this season's surveys over the revetments will not be fully developed until next year.

For the further benefit of the work for next season I would respectfully make the following recommendations: That the survey party be provided with three good transits, one to be provided with a solar attachment, one level, and two hand levels with stadia wires to facilitate the work of cross sectioning the upper slopes of the revetments. The instruments in use this season were old and worn, and with one exception all had other serious defects.

If a set of instruments as suggested should be provided, they should be retained for the exclusive use of the survey party and not be sent from place to place for the use of levee inspectors. The old instruments could be repaired and put in good condition, which would make enough and sufficiently good instruments to amply fulfill the needs of the levee department.

Respectfully submitted.

L. L. GRIFFITH, *Junior Engineer.*

Capt. E. W. VAN C. LUCAS,
Corps of Engineers.

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Abstract of cost of surveys 1904–5, to accompany report of L. L. Griffith, of date April 2, 1905.

Location.	Miles below Cairo.	Kind of survey.	Length of base line.	Number of ranges.	Shore line located.	Inclusive dates. From—	Inclusive dates. To—	Total days.	Actual working days.	Distribution of work. Recovering stone lines.	Locating base lines.	Retracing base lines.	Levels.	Locating ranges.	Cross-sectioning slope.	Sounding.	Shore line.	En route.	Cost.
			Feet.		*Miles.*	1904.	1904.												
Fletchers Bend[a]	160 R.	Detail	17,400	99	1	Aug. 30	Sept. 12	14	11	½	1½	....	1	1	2	2½	1	1½	$664.51
Hopefield Bend[a]	228 R.	....do	15,343	94	1	Sept. 13	Sept. 20	8	6	....	....	....	....	....	2	3	....	1	379.72
Wickliffe, Ky.[a]	5 L.	Shore line	....	....	6	Sept. 20	Oct. 3	14	13	....	....	....	....	....	....	....	1	7	664.51
Columbus, Ky.[a]	22 L.	....do	....	....	3	Oct. 4	Oct. 6	3	3	1½	....	....	....	....	....	....	½	1	142.39
Hickman, Ky.[a]	35 L.	....do	....	....	4	Oct. 7	Oct. 9	3	2	1	....	....	....	....	....	....	1	....	142.39
Slough Landing[a]	60 L.	....do	....	....	4	Oct. 10 Oct. 17	Oct. 12 Oct. 18	5	5	1½	....	....	....	....	....	....	3	½	237.32
New Madrid, Mo.[a]	71 R.	Detail	5,800	30	1	Oct. 13	Oct. 16	4	3	½	½	....	....	½	½	1	½	....	189.86
Caruthersville, Mo	110 R.	....do	2,400	13	2	Oct. 19	Oct. 20	2	2	½	½	....	....	½	½	½	....	½	94.93
Daniels Point, Ark.[a]	152 R.	....do	9,600	49	....	Oct. 21 Oct. 28	Oct. 25 Oct. 31	9	8	1	2	....	....	2	1	1	....	1	427.18
Chute of Island 26	....	General	....	14	....	Nov. 1 Nov. 5	Nov. 3 Nov. 8	8	6	2	....	....	....	2	....	1	1	....	379.72
Ashport Bend, Tenn.[a]	155 L.	Detail	15,900	80	....	Nov. 10	Nov. 15	5½	4½	½	1½	....	....	½	1½	1	....	....	261.05
Osceola bar, Ark	164 R.	....do	16,170	28	....	Nov. 28	Dec. 2	5	4	½	1	....	....	1	1	½	....	....	237.32
Bullerton bar, Ark	168 R.	....do	15,000	74	....	Dec. 10	Dec. 17	8	7	1	1½	....	....	1½	1½	1	½	....	379.72
Plum Point reach	....	General	....	56	41	Oct. 27 Nov. 4 Nov. 9 Nov. 16 Dec. 8 Dec. 18	Oct. 28 Nov. 10 Nov. 27 Dec. 9 Dec. 20	26½	21½	5	....	....	....	6	....	6	4½	....	1,257.82
Random Shot crevasse	194 R.	Hydrographic	8,100	14	1	Dec. 21	Dec. 24	4	3	½	....	½	....	1	....	1	....	....	189.86
			Meters.			Dec. 25	Dec. 31												
Hollybush crevasse	218 R.	....do	5,049	14	....	1905.	1905.	10	6	1	....	1	....	2½	....	1½	....	....	474.65
						Jan. 7	Jan. 9												
Memphis reach	....	General	....	56	14	Jan. 1 Jan. 10 Feb. 23	Jan. 6 Jan. 13 Feb. 25	12	10	2	....	....	....	3	....	3	2	....	569.56
			Feet.																
Memphis bar	229 L.	Cross section	3,600	19	....	Jan. 14	Jan. 17	4	3	....	....	½	....	1	1½	½	....	....	189.82
Memphis revetment	230 L.	Detail	9,235.9	46	....	Jan. 18	Jan. 26	9	8	....	2	....	....	....	2	4	....	....	427.18
Total								154	126	23½	9½	....	....	22½	....	....	....	....	7,309.51
Helena revetment[a]	307 R.	Detail	4,800	25	....														
Helena reach[a]		General	....	9	....	Jan. 4	Jan. 17	....	....	....	....	....	....	....	....	....	....	....	[b] 724.51
Walnut Bend[a]	282 R.	Hydrographic	....	18	10														
Grand total																			8,033.02

[a] Indicates maps completed to date.

[b] Surveys made by Junior Engineer Kerr.

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I. M. R.

1ST AND 2ND DISTRICTS

Capt. E. W. Van C. Lucas, Corps of Engineers, U. S. A.

In Charge.

Map of

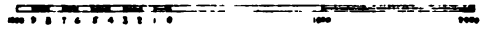
COLUMBUS, KY.

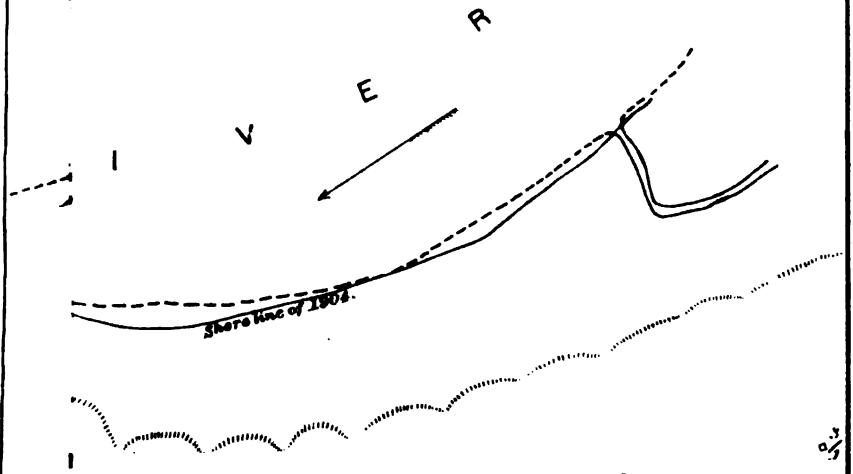
SHOWING

Dikes and Shore Line.

SCALE 1:15000

OCT. 1904





To accompany my annual report for the fiscal year ending June 30, 1905.

E. M. Chance

Captain, Corps of Engineers, U.S.A.

Digitized by Google

Abstract of cost of surveys 1904–5, to accompany report of L. L. Griffith, of date April 2, 1905.

Location.	Miles below Cairo.	Kind of survey.	Length of base line.	Number of ranges.	Shore line located.	Inclusive dates. From—	Inclusive dates. To—	Total days.	Actual working days.	Distribution of work. Recovering stone lines.	Locating base lines.	Refracing base lines.	Levels.	Locating ranges.	Cross-sectioning slope.	Sounding.	Shore line.	En route.	Cost.
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Hickman, Ky.[a]	35 L.	do	....	....	4	Oct. 7	Oct. 9	3	2	1	....	....	....	....	....	....	1	....	142.39
Slough Landing[a]	60 L.	do	....	....	4	Oct. 10 Oct. 17	Oct. 12 Oct. 18	5	5	1½	....	....	....	....	....	....	3	½	237.32
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Caruthersville, Mo	110 R.	do	2,400	13	2	Oct. 19	Oct. 20	2	2	½	½	....	....	½	½	½	....	½	94.93
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Bullerton bar, Ark	168 R.	do	15,000	74	....	Dec. 10	Dec. 17	8	7	1	1½	....	....	1½	1½	1	½	....	379.72
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Random Shot crevasse	194 R.	Hydrographic	8,100	14	1	Dec. 21	Dec. 24	4	3	½	....	½	....	1	....	1	....	....	189.86
Hollybush crevasse	218 R.	do	*Meters.* 5,049	14	....	Dec. 25 1905.	Dec. 31 1905.	10	6	1	....	1	....	2½	....	1½	....	....	474.65
Memphis reach	....	General	....	56	14	Jan. 7 Jan. 1 Jan. 10 Feb. 23	Jan. 9 Jan. 6 Jan. 13 Feb. 25	12	10	2	....	....	....	3	....	3	2	....	569.56
			Feet.																
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I. M. R.

1ST AND 2ND DISTRICTS

Capt. E. W. Van C. Lucas, Corps of Engineers, U. S. A.

In Charge.

Map of

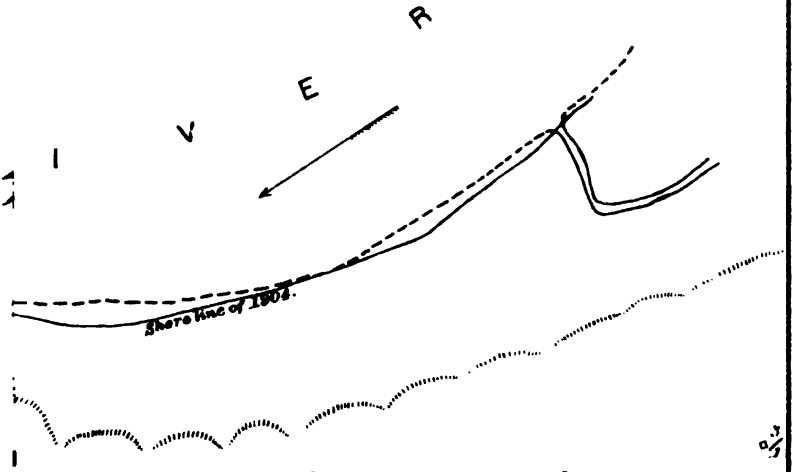
COLUMBUS, KY.

SHOWING

Dikes and Shore Line.

SCALE 1:15000

OCT. 1904



To accompany my annual report for the fiscal year ending June 30, 1905.

E. Mac Chesney

Captain, Corps of Engineers, U.S.A.

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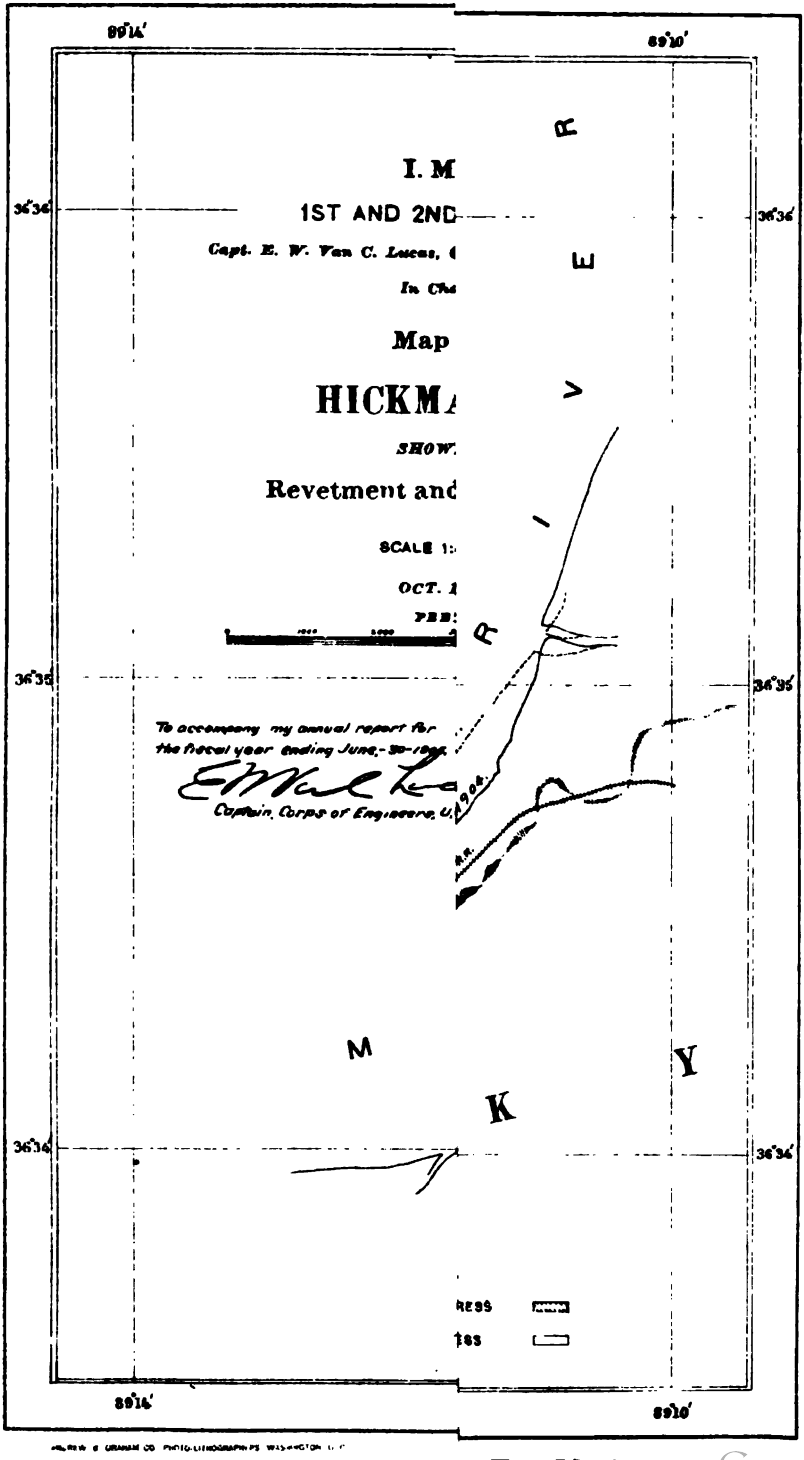

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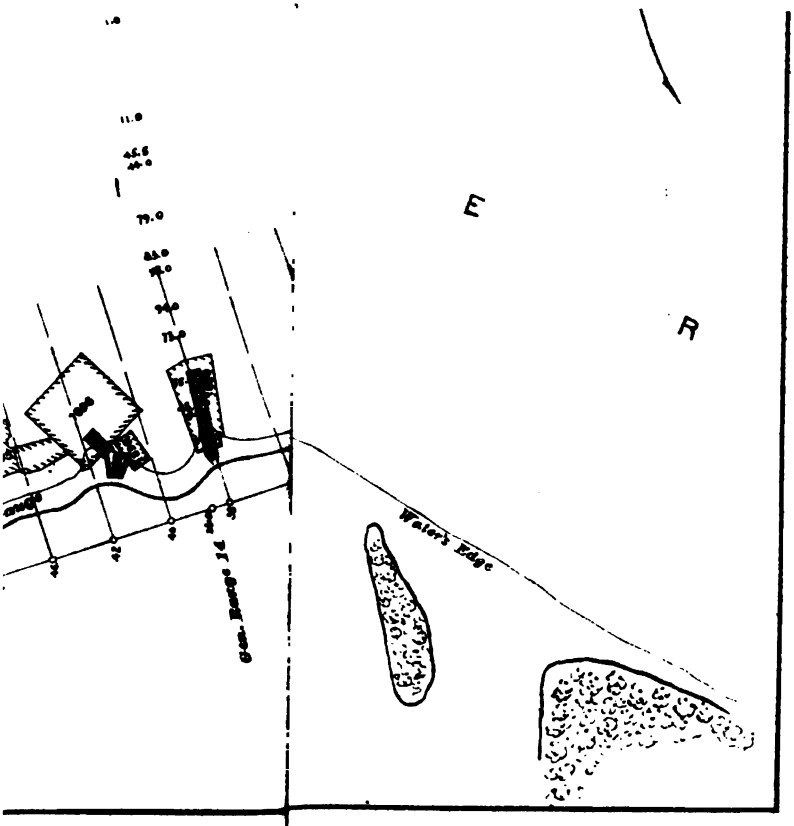

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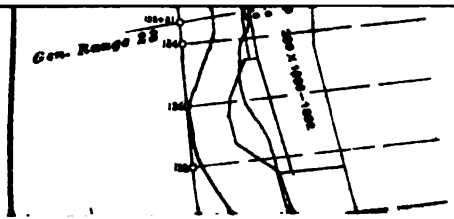

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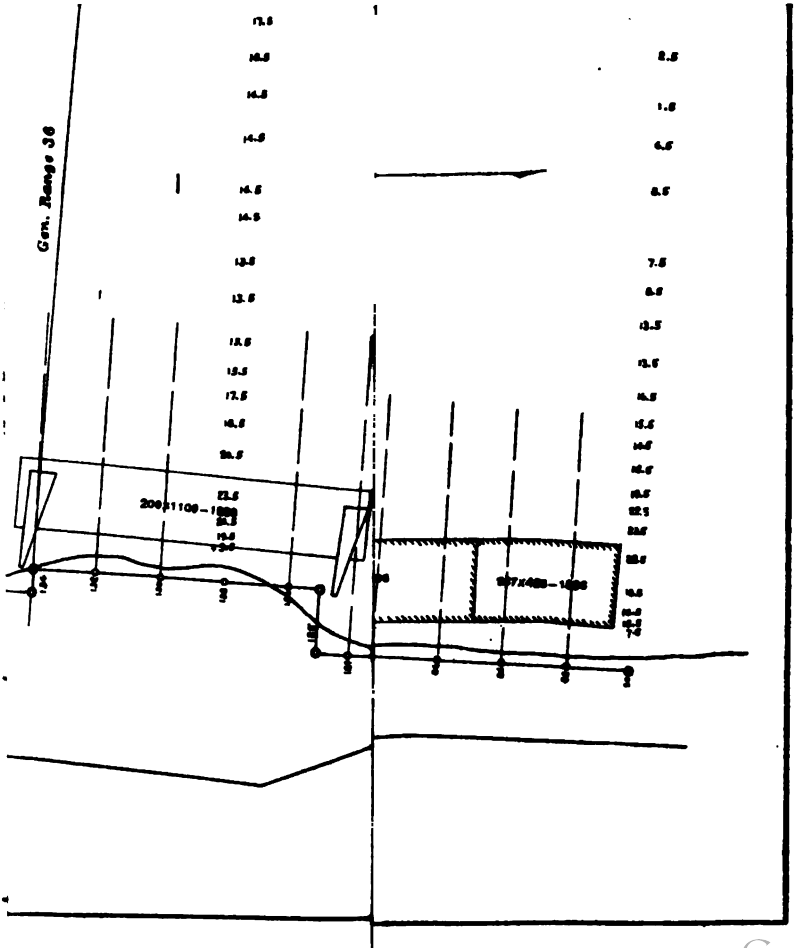

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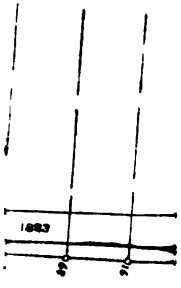

A BAR

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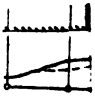

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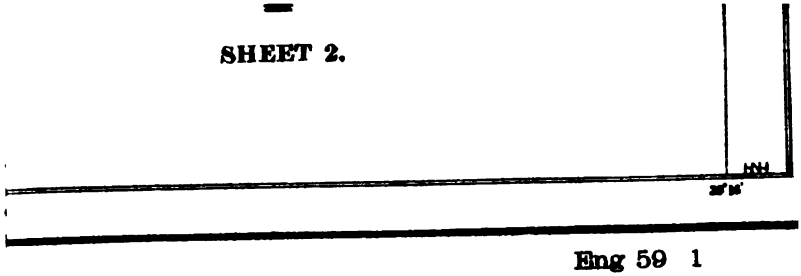

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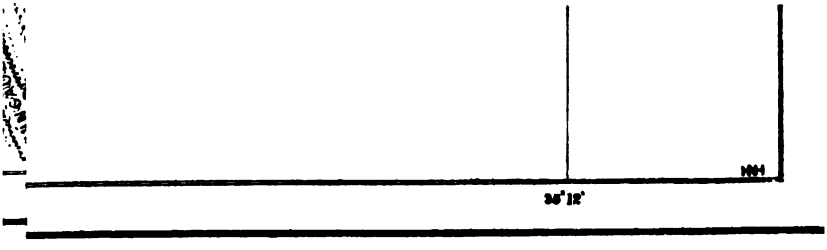

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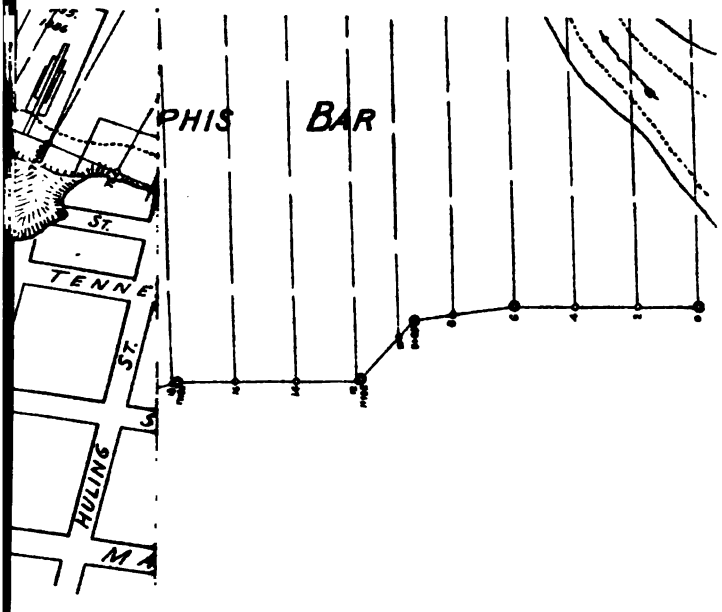

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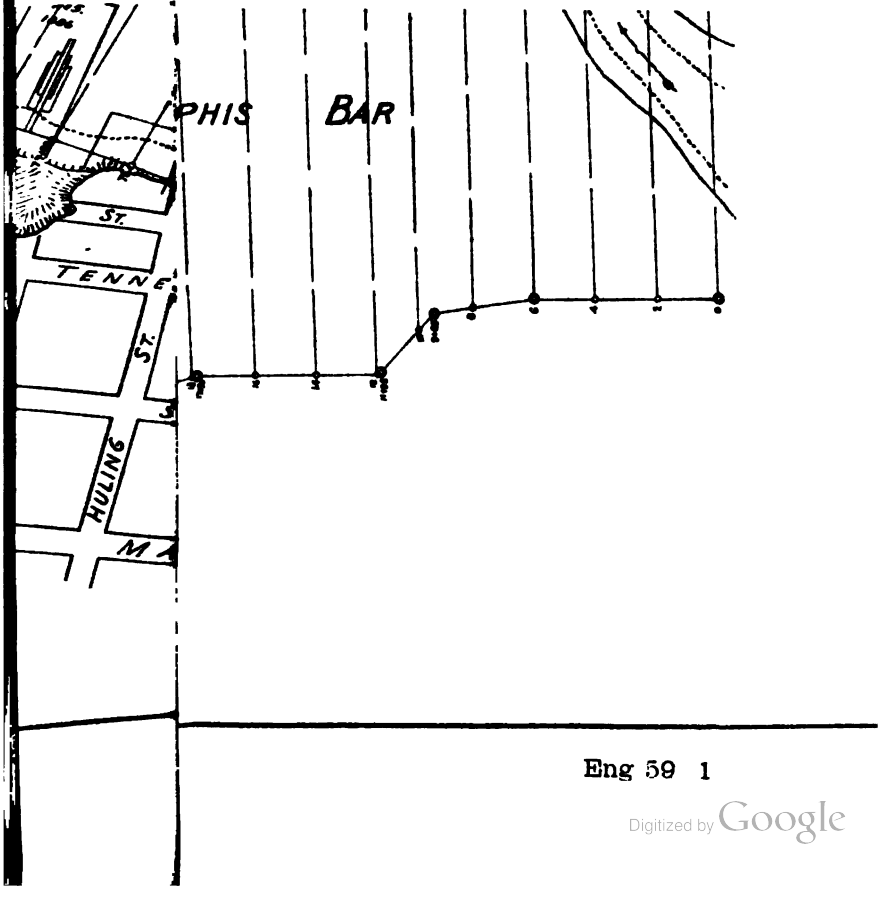

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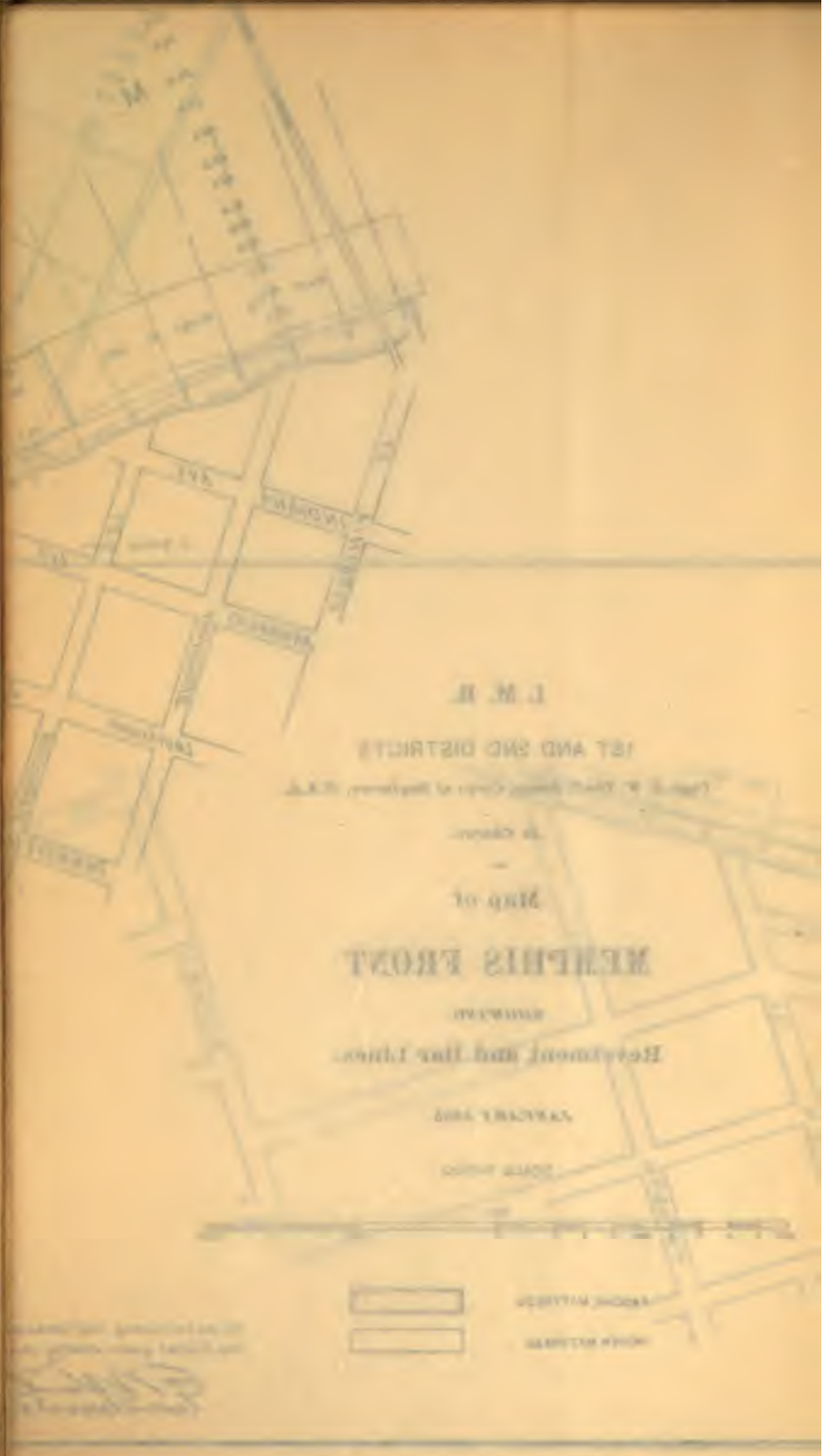

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Luther Y. Kerr, U.S. Jr. Eng'r.

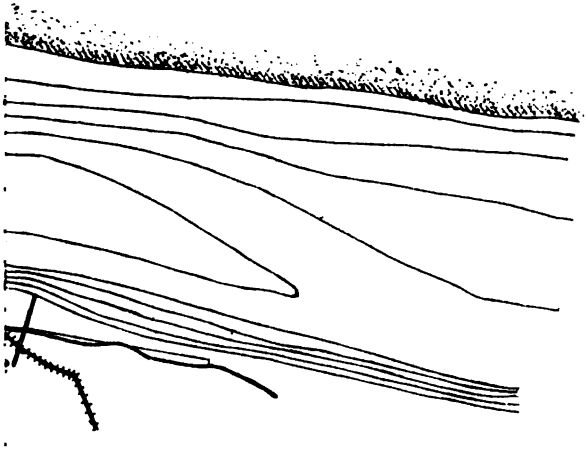
January 1905

SCALE 1-15000

ge taken at 4½ ft. stage Helena gage
nd reduced to zero of same.

To accompany my annual report for the fiscal year ending June 30, 1905.

E. Mackenzie
Captain, Corps of Engineers, U.S.A.



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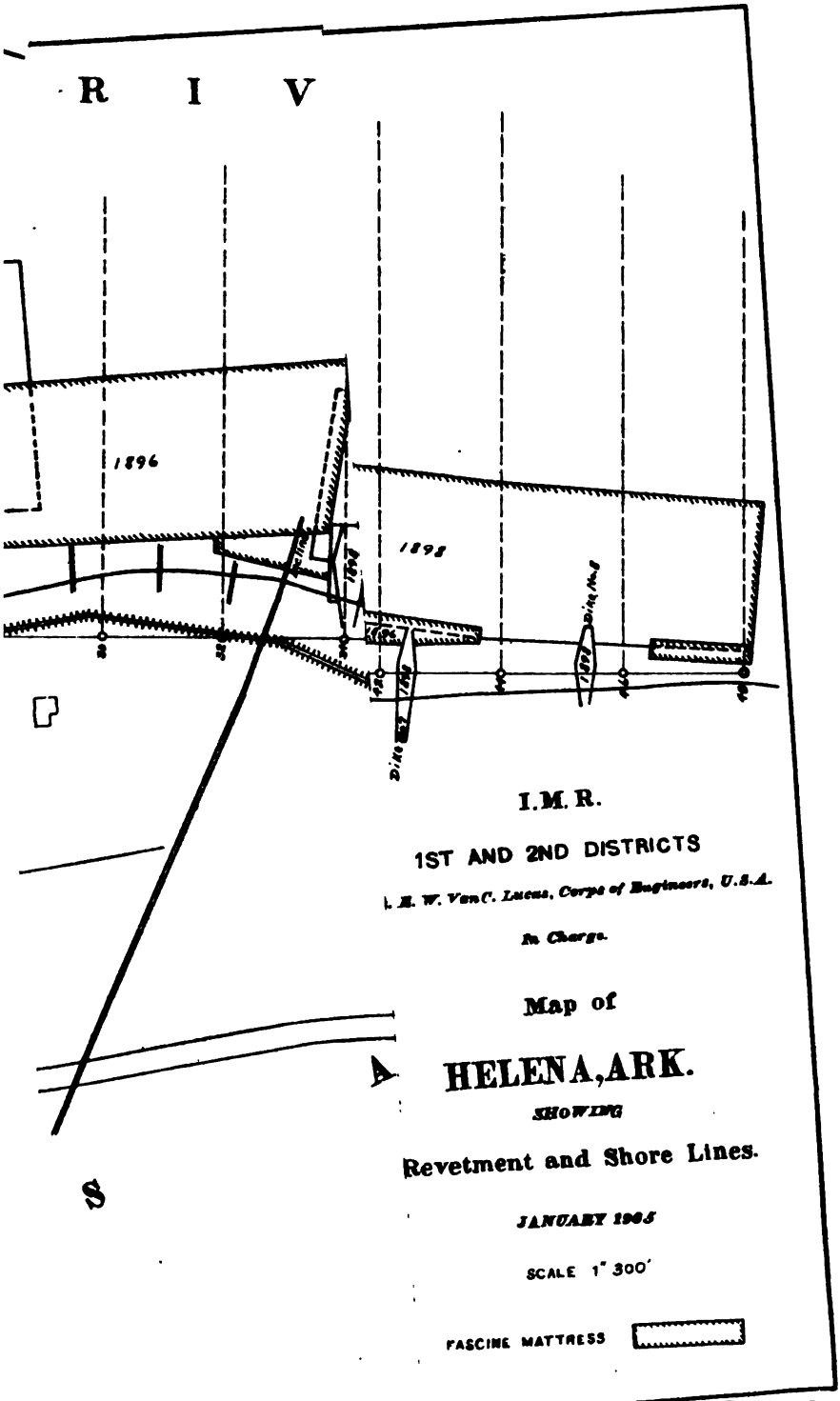
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1895
Dike No. 2
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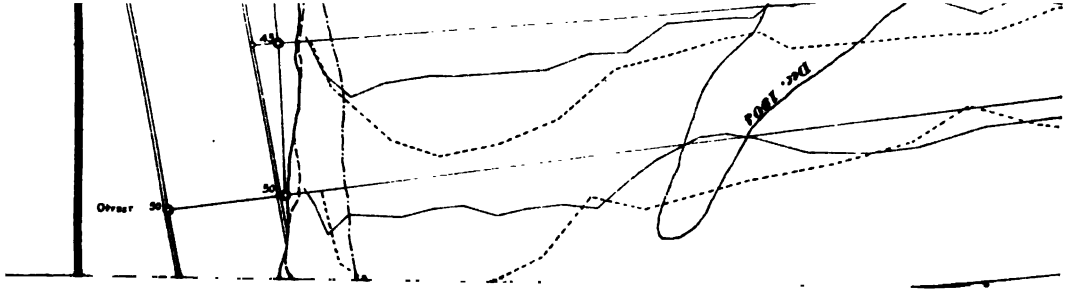

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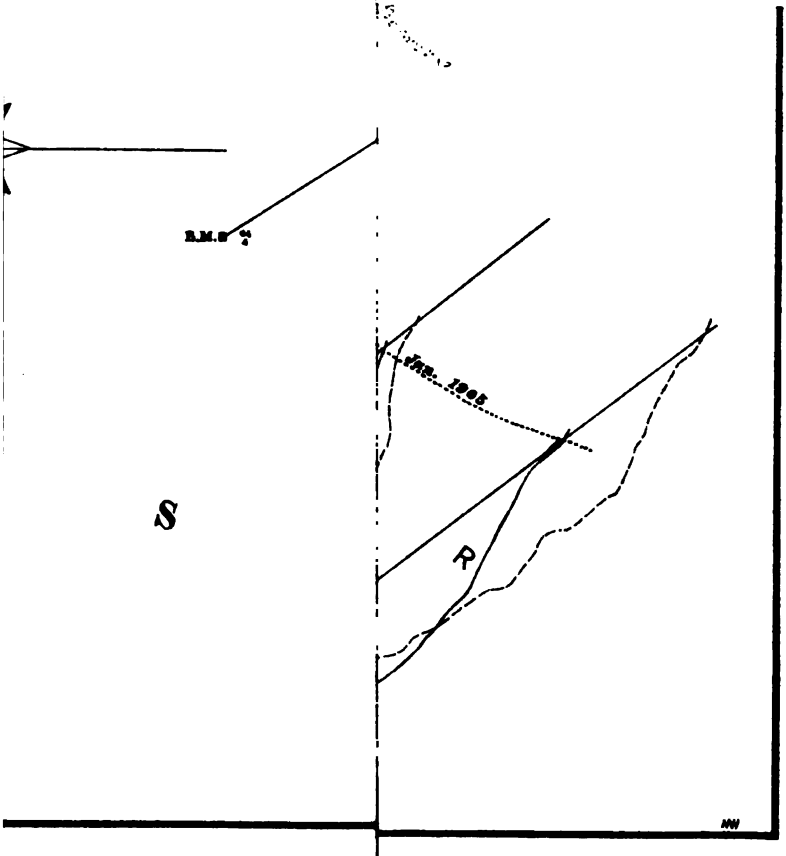

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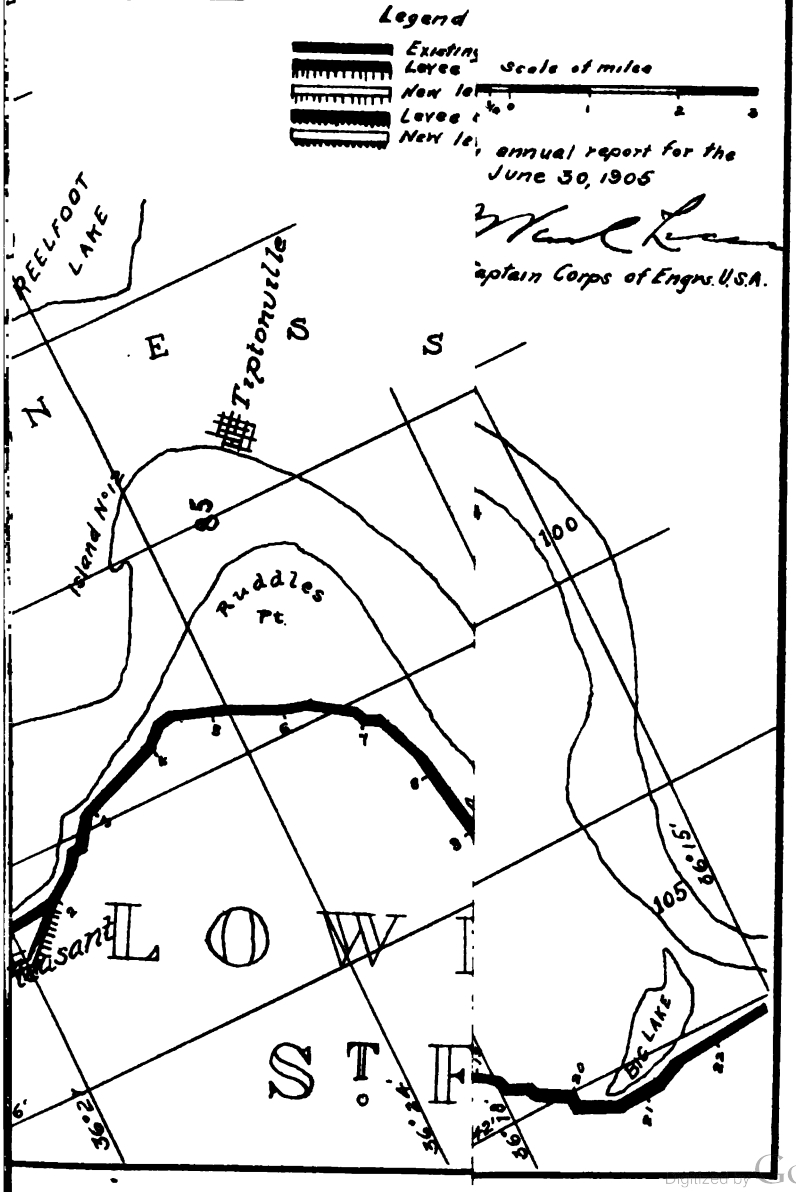

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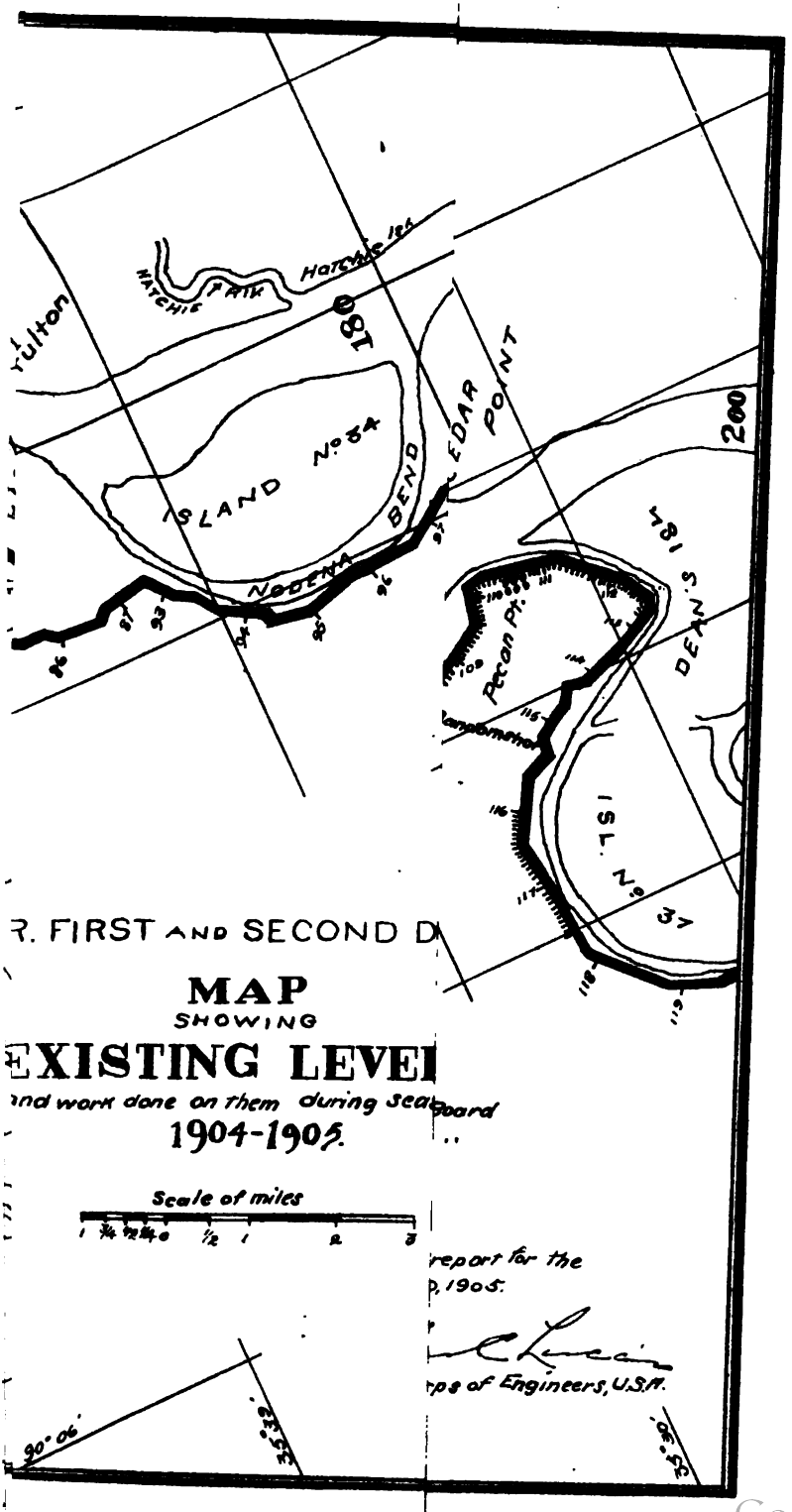

R. FIRST AND SECOND D

MAP

SHOWING

EXISTING LEVEI

and work done on them during seaboard

1904-1905.

Scale of miles

1 ¼ ½ ¾ 0 ½ 1 2 3

report for the

p. 1905.

ps of Engineers, U.S.A.

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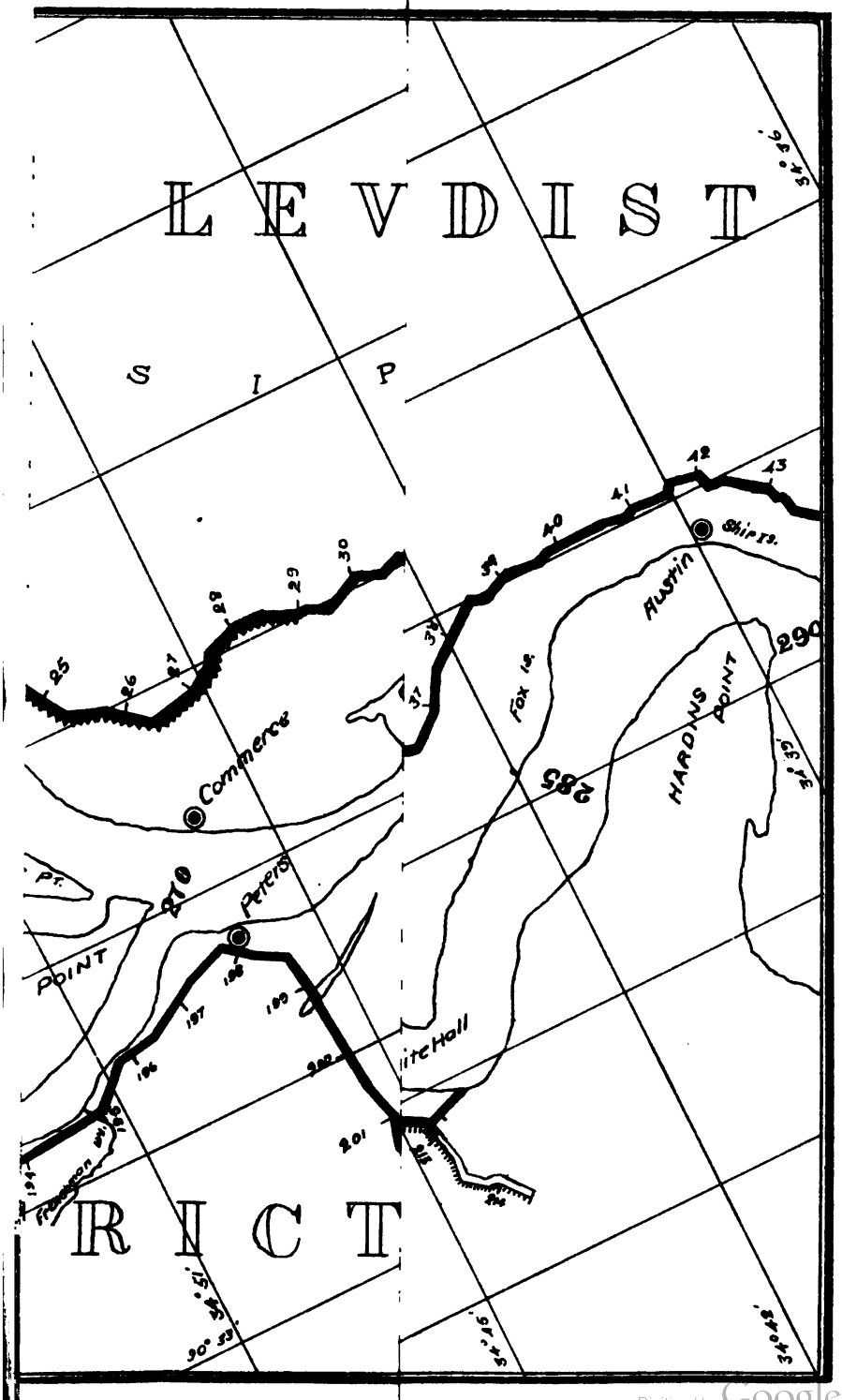

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I.M.R. FIRICTS

EX

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-Legend-

Existing Levee
Levee enlarged by U.S.
New Levee built by U.S.
Levee enlarged by Levee
New Levee built by -

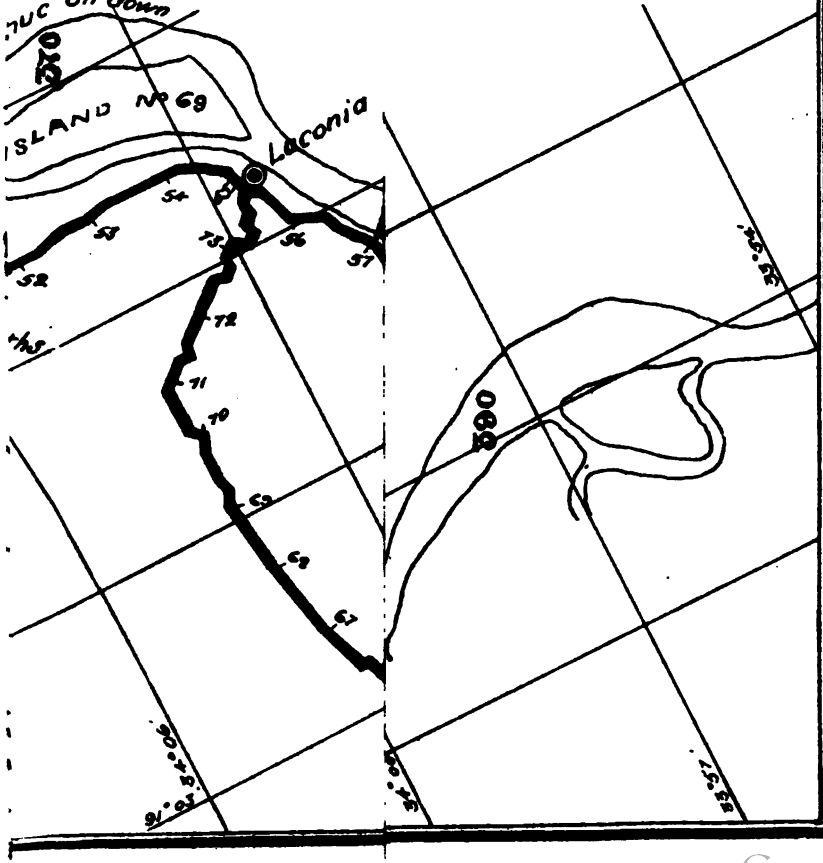
ls of miles

1 2 3

ual report for the
e 30, 1905.

Wm C Lucas

n. Corps of Engineers, U.S.A.



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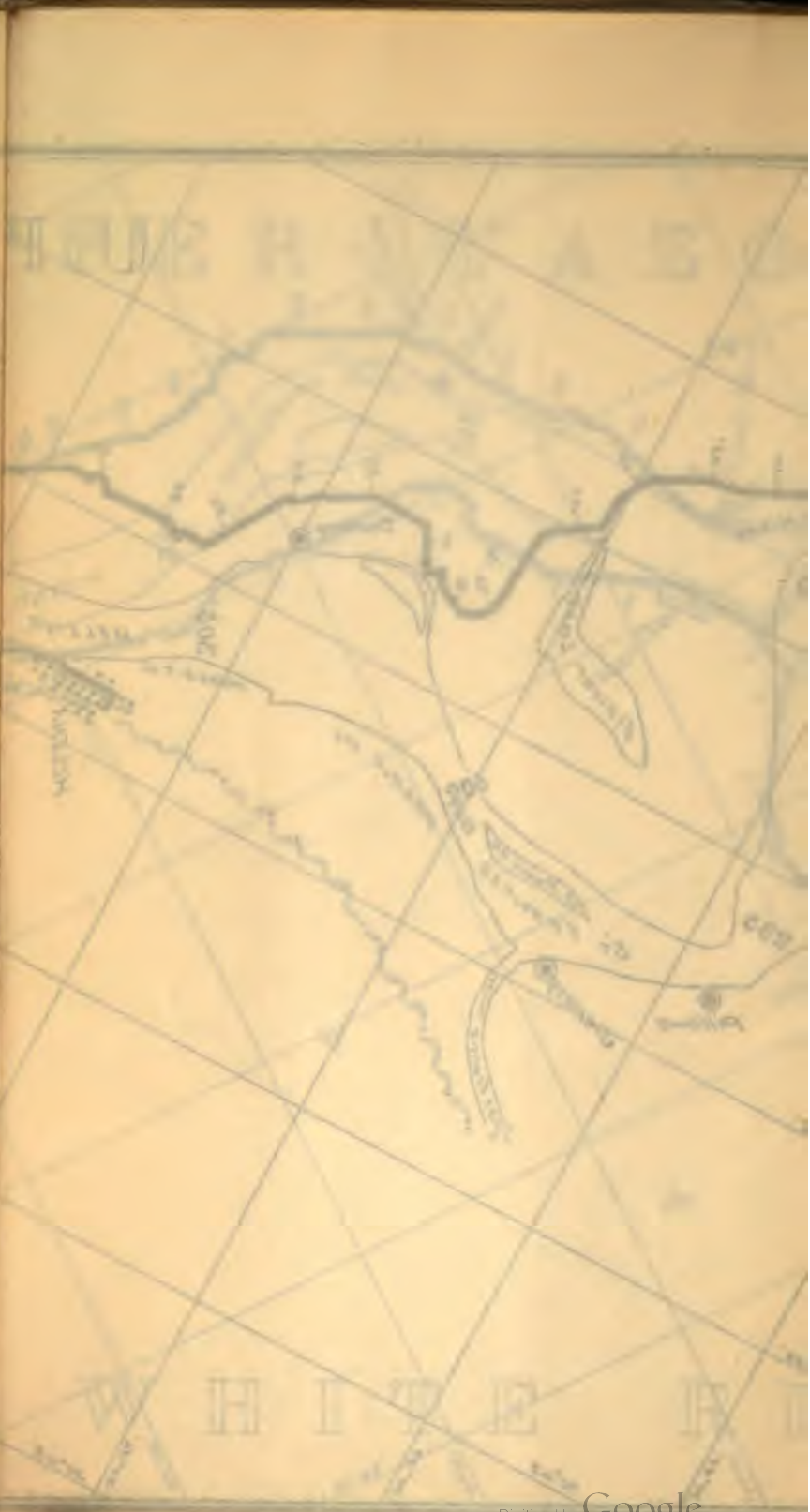
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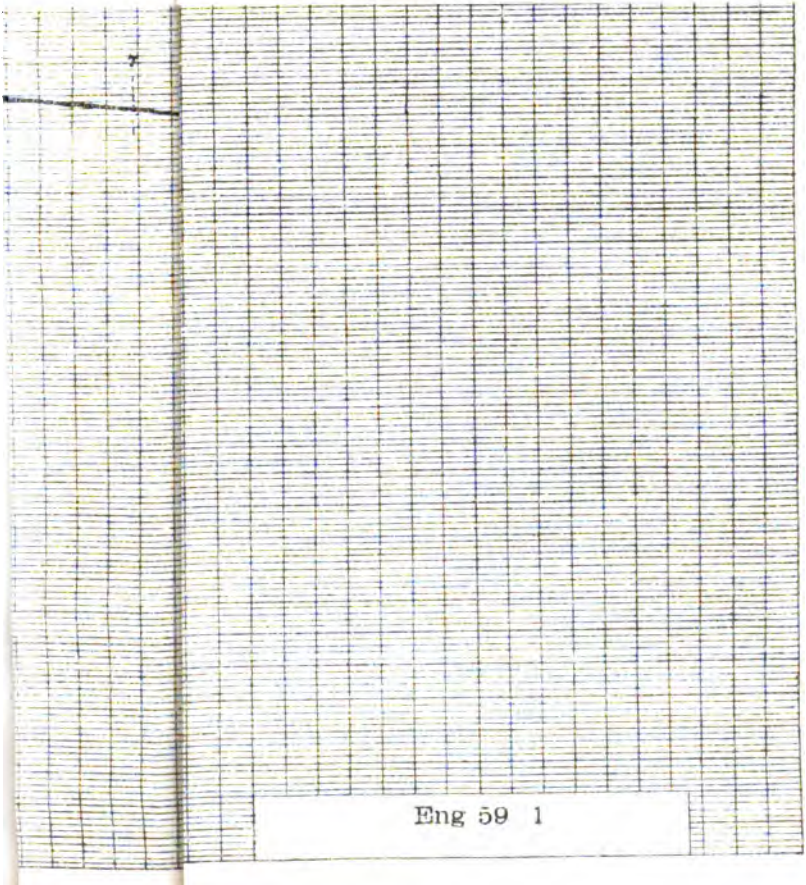

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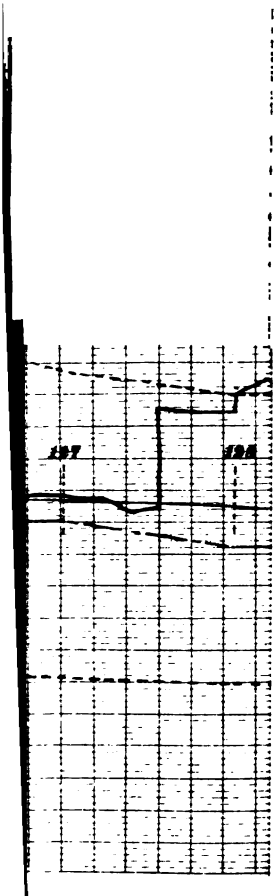

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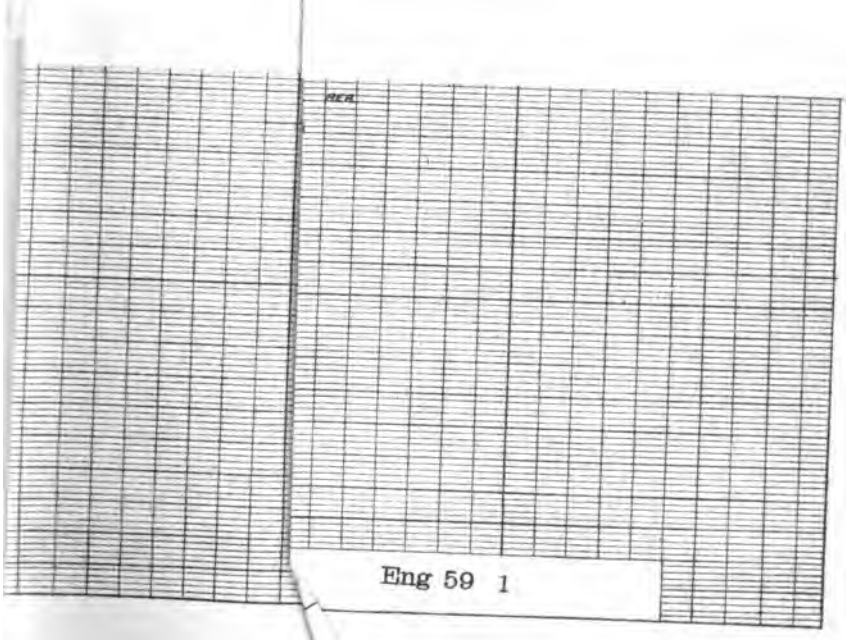

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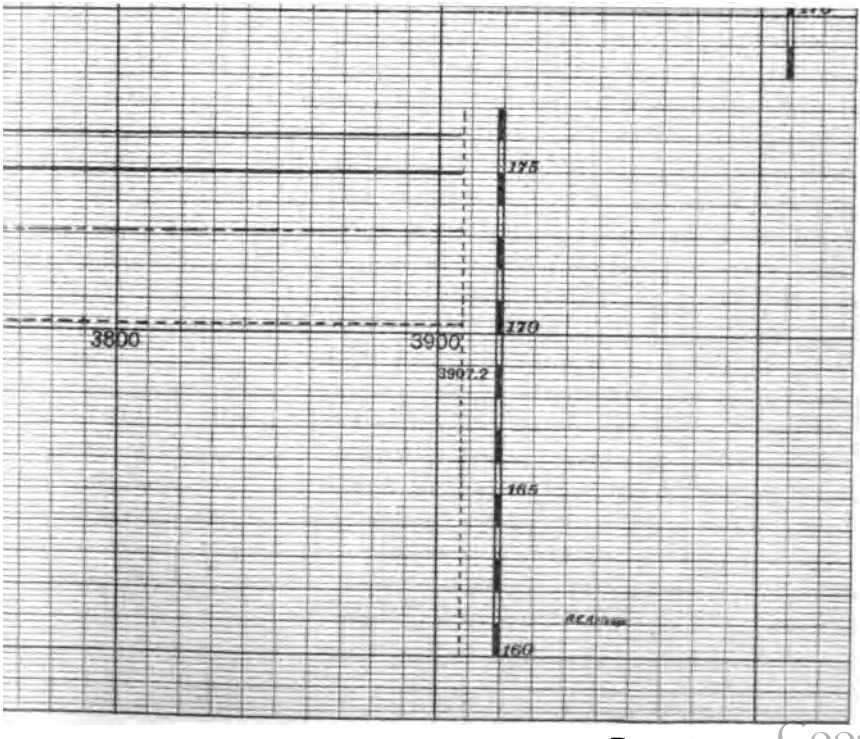

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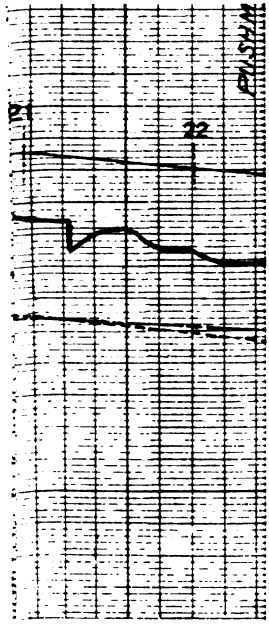

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APPENDIX 3.

REPORT OF CAPT. G. M. HOFFMAN, CORPS OF ENGINEERS, ON OPERATIONS IN THE THIRD DISTRICT.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., May 31, 1905.

COLONEL: I have the honor to submit the following report of operations in the third district, Mississippi River improvement, for the year ending May 31, 1905:

Capt. E. W. Van C. Lucas, Corps of Engineers, was in charge of the district from the beginning of the year to February 1, 1905, on which date the work was transferred to me.

The third district extends from the Coahoma-Bolivar county line on the left bank (365 L.), and the mouth of White River on the right bank (393 R.), to the latitude of Warrenton, Miss. (607 L.). The work on this section of the river includes bank revetment at Lake Bolivar front, Ashbrook Neck, Greenville, and Longwood, Miss., and at Lake Providence, Louisiana Bend, and Delta Point, La.; the systematic improvement of Lake Providence reach, which has been discontinued, and levee construction and maintenance in the Lower Yazoo and Upper Tensas levee districts.

PART 1.—CHANNEL WORK.

Lake Bolivar front, Miss. (*417 L.*).—(For description and history see summary herewith.) The work here consists of about 3,775 feet of effective bank revetment placed to hold a caving bank which endangered the large and important levee across the head of Lake Bolivar. (See map No. 2, herewith.) Due to a change in the river channel above and the scouring away of a bar which partially masked this work a more direct attack by the current has been established, resulting in a marked deepening along the outer edge of the mattress, especially at the lower end. At this point a considerable slough has occurred, destroying about 100 feet of the upper-bank paving and probably involving a short length of the mattress. The mattress is of the old-style woven type and was constructed in 1888–89. A reenforcing mattress of the same type, covering 500 feet at the lower end, was placed in 1893. Under the changed conditions the structures can no longer be relied on, and it is contemplated, during the coming season, to reenforce it with standard fascine mattress having a length of about 2,000 feet.

No work has been done during the year.

Ashbrook Neck, Miss. (*446 L.*).—(For description and history see summary herewith.) The work here consists of 10,100 feet of effective bank revetment built to prevent a cut-off. (See map No. 3, herewith.) It has been necessary from time to time to reenforce the original mattress, which was of the old-style woven type. There still remains 2,000 feet of the old work not reenforced; of the balance 7,600 feet is reenforced with the standard fascine mattress and 500 feet is original fascine mattress. During the year repairs were made to the upper-bank paving at three places where small breaks had occurred, the cost of which amounted to $4,942.11; payments were made from allotments applicable to this work from appropriations of March 3, 1903, and April 28, 1904. (For details see report of Assistant Engineer Arthur Hider, Appendix 3 A, herewith.) While the work is in excellent condition, the unreenforced sections, 1,150 feet and 900 feet long, respectively, show indications of failure, and their weakness has been the probable cause for many of the repairs made. During the coming season it is contemplated to reenforce these sections with standard fascine mattress and to make such minor repairs as may be necessary.

Greenville Harbor, Miss. (*478 L.*).—(For description and history see summary herewith.) The town and harbor of Greenville is protected by bank revetment having an effective length of 12,100 feet, of which 1,400 feet is of the old type woven mattress and 10,700 feet of such type reenforced with standard fascine mattress. (See map No. 4, herewith.)

Repair work during the past season consisted of the placing of three small pocket mats; the cost, amounting to $7,003.21, was paid from allotments applicable to this work from appropriations of March 3, 1903, and April 28, 1904. (For details see report of Assistant Engineer Arthur Hider, Appendix 3 A, herewith.)

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During the bank-full stage of the river this spring a sudden break occurred at and above the discharge pipe of the sewage pumping plant; 259 feet of the upper-bank paving sloughed in, and the inner end of the mattress sank a maximum of 20 feet. The latter is apparently intact; since the first break no further changes have been noticeable. The contemplated work for the coming season includes the repair of this break, and such minor repairs as may be necessary.

Longwood, Miss. (*500 L*).—Bank revetment was begun here last fall to hold the rapidly caving bank and prevent the destruction of the levee. Before undertaking this work, surveys were made of locations for a new loop, and it was only after careful study of the several methods of meeting the situation, and their comparative cost, that decision was made in favor of holding the bank. The estimated cost of the loop on the location considered the best, plus the cost of right of way and land damages, was $793,000; while the cost of the revetment now in place, plus the cost of the needed extension and a short loop at the lower end, will be about $315,000. The latter constructions may result in solving the problem without any additional expenditure, as the proposed extension of the revetment will reach a resisting bank protected by an old cypress brake, and the threatened angle of the levee further below will be covered by the proposed short loop. (See maps Nos. 5 and 10, herewith.)

Work during the season was carried on under an allotment of $100,000 from appropriation for fiscal year 1905 (act of April 28, 1904) and a reallotment from Lower Yazoo levee district of $50,000 from the same appropriation.

Payments amounting to $11,009.45 were made by the Mississippi levee board for stone used in this work, the allotment for same being insufficient and the need for the material being urgent.

The total cost of the season's work was $152,471.51, making the cost per linear foot of revetment $36.31.

Six mattresses were constructed, making a total effective length of 4,200 feet; in addition, nine small connecting mats were placed. Part of the first mattress was lost during sinking, due to the breaking of the manila cables which held the mooring barges in place. Precaution had been taken to increase the number of these cables to seven, and to use only new 2-inch lines on account of the swift current of 5½ feet per second prevailing. The outer line, which later test showed to be below specified strength, parted first, and the others failed in succession to support the great additional stress thereby placed upon them. The stone barges engaged in weighting the mattress were attached to the mooring barges; and, on the failure of the lines, they all floated down over the mattresses. The tug became helpless from a loose line caught in the wheel, so that it and the barges lodged against the floating end of the mattress and tore it in two. The loose section floated downstream, involving a loss of 434 linear feet, valued at $7,307.61.

The remainder of the work was carried to a successful completion, though considerably delayed and increased in cost by the scarcity of labor, and the demoralization of the force by the breaking out of smallpox. The local supply of labor was not sufficient and it was necessary to pay the transportation of forces obtained in St. Louis and Memphis.

The bank was graded to a slope of about 1 to 3 and paved to a height of 30 feet above low water, except for a short section which was carried only to 26 feet. Part of the riprap paving was placed directly on the earth slope, and part was underlaid with a 3 to 4 inch layer of quarry spalls; the different sections were carefully mapped with a view of inspecting them from time to time and determining the relative stability of the two types of paving under the same conditions. Experience in other work indicates that the layer of spalls, though increasing the first cost, will almost eliminate the necessity, heretofore obtaining, of yearly expenditure for expensive repairs.

In order to complete this work before the annual rise it became necessary to transfer a mattress party and outfit from the first district. It was of great value, not only on this account, but also for the opportunity afforded for comparing details of plant and methods. Some slight changes will be made as the result of this comparison. (For details see report of Assistant Engineer Arthur Hider, Appendix 3 A, herewith.)

The work contemplated during the coming season consists of the extension of the revetment for a distance of 1,000 feet downstream.

Lake Providence reach (*517–552 R.*).—(For details and history see summary herewith.) This section of the river was selected by the Commission soon after its formation for improvement of the low-water channel by means of contraction

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works and revetment of caving banks. Though marked deepening of shallow crossings resulted, the work was finally discontinued because of the lack of funds and the enactment of a law limiting the use of bank revetment. Most of the structures, which were comparatively weak, have been destroyed. In later years active revetment work was resumed at Louisiana Bend and at Lake Providence, but with special objects in view.

Louisiana Bend, La. (522 R.).—(For description and history see summary herewith.) The revetment of the caving bank in this bend was undertaken with a view of obtaining greater permanence in the channel below. About 4,000 feet of the lower end, which was of old-style woven mattress, except for 600 feet fascine mattress reenforcement, has been destroyed, and more than half of the remaining 11,820 feet is covered by a bar at the upper end. (See map No. 6, herewith.)

No work was done during the year and none is contemplated.

Lake Providence, La. (540 R.)—(For description and history see summary herewith.) The town of Lake Providence and the important levee across the foot of the lake is protected by bank revetment having an effective length of 12,600 feet; of this 2,200 feet is old-type woven mattress, 700 feet is woven mattress reenforced with fascine mattress, 5,000 feet is fascine mattress reenforced with fascine mattress, and 4,700 feet is original fascine mattress. (See map No. 7, herewith.)

The season's work consisted of repairs of three small breaks and one considerable break in the upper-bank paving. Connecting mats were placed overlapping the original mattress, the upper bank was resloped and repaved, and drains were constructed. Total expenditures for the season's work amounted to $31,656.01, from allotment applicable thereto, appropriations of March 3, 1903, and April 28, 1904. (For details see report of Assistant Engineer Arthur Hider, herewith, Appendix 3 A.) Part of the work was done with the first district plant and party, which were transferred here after completing its portion of the work at Longwood. Progress of the work was delayed by the breaking out of an epidemic of smallpox, which caused a suspension of the work from February 1 to 15, and finally the disbandment of the first district party; the work was finally completed with the third-district plant and party transferred from Longwood after the work there was finished.

In 1901 a channel was forming at the upper end of this work, and the increased current and its direction threatened to flank the mattress there. To prevent this a cut was dredged, which has accomplished the purpose in view; the incipient channel has filled up and a bar has formed, masking about 4,000 feet of this revetment. The attack has been transferred to the middle and the lower end, where the structures are better able to resist it. (See map No. 11, herewith.) There are, however, two sections, 1,200 and 600 feet long, of old-type woven mattress unreenforced in the portion now subjected to attack. During the coming season it is contemplated to reenforce as much of these sections as funds available will permit.

Delta Point, La. (598 R.).—(For description and history, see summary herewith.) This revetment was placed to hold the point and prevent further recession of the channel from the town and harbor of Vicksburg; it has an effective length of 5,900 feet, of which 4,600 feet is of woven mattress, 600 feet is of woven mattress reenforced with fascine mattress, and 700 feet is of original fascine mattress. (See map No. 8, herewith.)

Annual hydrographic surveys have been made of the reach the past two years for the purpose of watching the channel movement; this has a tendency that may eventually threaten the West Pass levee, built to protect Vicksburg Harbor. (See map No. 13, herewith.) These surveys should be continued. No work except the survey was done last season, and no other is contemplated for the coming season.

Stone.—Stone for the season's work was obtained from three sources: At the Government quarry on the Little Red River 11,376.4 cubic yards were quarried by day labor and towed by Government boats, at a rate of $1.21 for quarrying and loading and $0.5436 for towing; the cost of 5,811.6 cubic yards used direct from barges was therefore $1.7536; the cost of 5,564.8 cubic yards on the bank was increased $0.172 for unloading to $1.9256, while the cost of 3,874 cubic yards of this amount delivered on barges was still further increased by $0.3557 for reloading to $2.2813 per cubic yard. The average cost of stone actually used was $1.953 per cubic yard delivered on barges. Under a contract with J. J. Ball & Co., 15,139.56 cubic yards were delivered on the bank at Arkansas City at $1.55 per cubic yard; this stone was loaded with carts and wheelbarrows, at

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a unit cost of $0.40, making a total cost of $1.95 per cubic yard on barges. Under a contract with Chas. J. Menges, 4,125.96 cubic yards were delivered on barges at the Longwood revetment for $1.75 per cubic yard. The slowness of delivery by contract made it necessary to draw on the reserve supply at Greenville, of which 3,874.1 cubic yards were loaded on barges with carts at a unit cost of $0.3557, as stated above.

There is now on the bank at Greenville a reserve supply of 10,000 cubic yards and at the Government quarry about 1,700 cubic yards.

The quarry force was disbanded May 25, 1904, and the quarry has not since been reopened, as the moderate high-water stages could not be counted on to give reliable boating depths in the Little Red River. It is probable also that, with power appliances for loading, purchase by contract will prove more economical. As the supply for the coming season will have to be obtained by contract, it is contemplated to install simple power appliances to demonstrate this point, careful study having shown that a considerable saving may thus be expected.

The total cost of stone delivered during the year was $51,594.05, which, less $11,009.54 paid by the Mississippi levee board, was paid from allotments applicable thereto; it was all charged in proper proportions to the various works and included in the cost thereof. (For details see report of Assistant Engineer Arthur Hider, Appendix 3 A, herewith.)

Plant.—Repairs necessary to maintain the plant in good condition were made at a cost of $17,129.37 for the year. The cost of caring for plant and other property was $19,650.94, making the total expenditure for care and repairs $36,780.31. No new plant was built. (For details see report of Assistant Engineer Arthur Hider, Appendix 3 A, herewith.)

The estimated cost of ordinary and extraordinary repairs during the coming year is $25,467.50. The extraordinary repairs in view include docking, scraping, and painting hull of towboat *Arthur Hider*, estimated cost, $3,200; repairs to hydraulic grader, estimated cost, $2,500, and extensive repairs to some of the older barges and quarter boats, estimated cost, $7,062.50. The only new plant in contemplation consists of a power appliance for loading stone from storage pile to barges and equipment of a derrick barge for unloading from barges to bank being paved; the estimated cost is $3,000. (For details see report of Assistant Engineer Arthur Hider, Appendix 3 A, herewith.)

Revetment work in general.—Total expenditures for revetment construction amounted to $196,072.84, of which $43,601.33 was for repairs and $152,471.51 for new work; the cost of stone and all other materials expended is included in the above, as well as a proportion of the main office expenses. The item for new work included $11,009.54 paid by the Mississippi levee board for stone used at Longwood. Expenditures incidental to revetment work were $36,780.31 for care and repair of plant, and $5,000.92 for surveys.

Repairs and reenforcement of revetments of an approximate present valuation of $1,500,000 have cost during the last three years an average of $76,700 annually, or 5.1 per cent, not including maintenance of plant, which is about 2.6 per cent annually. Considering all the circumstances, the necessity of renewing old work of weak construction, the attacks to which the works are subjected, etc., this is not an excessive charge. It is, nevertheless, a considerable item and its possible reduction deserves close study; also the question of reducing the cost of new work, which has undoubtedly been increasing from various assignable causes. The lines on which the accomplishment of these objects may best be sought are greater stability of construction, especially of the upper bank paving; thorough drainage of old borrow pits and the batture generally to reduce the saturation of the banks to a minimum; the use of power appliances for handling stone, and any other expedient that will eliminate as far as practicable that most potent factor of increased expense, the labor problem.

Uniformly itemized reports of cost of all the revetment work in the several districts would be of great value.

Surveys.—The regular surveys of bank revetments and caving bends have been made; also additional reach surveys below Lagrange and Hollybrook crevasses and above Delta Point. Expenditures for this purpose were $5,000.92 under allotments from appropriations of March 3, 1903, and April 28, 1904. (For details see report of Junior Engineer L. Y. Kerr, Appendix 3 B, herewith.) (See maps Nos. 2 to 13, herewith.)

The reach surveys below the 1903 crevasses were for the purpose of throwing light on the question of channel changes due to a crevasse and its subsequent

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closure. The results show a fill in one case and a scour in the other, so that no positive conclusions can be drawn. Further surveys appear to be unnecessary, on account of the discrepancies in the data to date and the improbability of their being reconciled by future changes.

PART 2.—LEVEE WORK.

SECTION I.—SUMMARY.

Levee building in Mississippi prior to 1882.—Of the 314 miles of levee now existing in Mississippi, 124 miles are in the second and 190 miles in the third district, the point of division being on the Coahoma-Bolivar county line. So little of the history of levees in Mississippi prior to 1882 belongs especially to the upper district that this sketch of this period will include both districts.

In 1844 many isolated levees existed along the lower part of the Yazoo front. All levee building in the years immediately following was done by planters along their own fronts.

Later a "Superior board of levee commissioners" was organized and was in existence until 1858, but its power was only nominal. The counties fronting on the river did a great deal of work and became very much in debt. It is estimated that of this indebtedness Bolivar County owed $197,000; Washington County, $165,000; and Issaquena County, $100,000.

In 1858 a levee district was formed for the Yazoo Basin, including the back counties to be protected. A tax of 10 cents per acre was laid on all lands to be protected, and the front counties were permitted to lay an additional tax of 25 cents an acre on all the lands within their own borders. Contracts were entered into in the years 1860–61 to the amount of $1,250,000, but the war caused a suspension of the work, and there is no record left of how much work was done under these contracts. These levees had a crown 5 feet wide, a front slope of 6 to 1, a back slope of 2½ to 1, and had grades varying from 4 feet in De Soto to 5.4 feet in Issaquena County above the highest known water, which at some points was that of 1858 and at others that of 1859. Though the levees built under the organized levee board were breached in many places by the floods of 1862, 1865, and 1867, and required work to close the crevasses formed, they were built to such a height that no enlargement of them was undertaken until about 1890.

After the war there was a division between the upper and lower front and back counties. In 1871 the upper district was organized under the name of district No. 1. It comprised De Soto, Tunica, Coahoma, Tallahatchie, and Panola counties and six townships of Sunflower County. In 1876 it had become very much in debt and was abolished by law.

In 1865 the lower district was organized under the name of the "Board of commissioners for Bolivar, Washington, and Issaquena counties." Its principal source of revenue was a tax of 1 cent per pound on cotton, which produced a large income. Prices for levee construction were, however, very high (40, 50, or 60 cents per cubic yard), and the administration often very lax; the result being that they had very little to show for the large expenditures of this period. In 1876, upon the abolition of district No. 1, this (lower) district, being then the only one in the State, changed its name to "The Mississippi levee district," which is still its official title. From 1876 to 1882 it was administered by a "reform board," which devoted itself to retrenchments. It paid off half a million dollars of its indebtedness and reduced the cotton tax to $1 per bale, or less. The flood of 1876, the highest since 1867, was of only a moderate height; the enlargement of the levee was therefore regarded as unnecessary and the levee construction was limited to the new loops required in front of caving banks. In 1882 the great flood came, which "wiped out levees and board alike." The only engineering records of this district during this period that have been preserved are contained on a map of a survey of the levee in 1867, made under direction of Mr. Minor Merriwether, engineer of the levee board of the lower district.

Floods of 1882, and condition of levees, etc.—The flood of 1882 was the greatest known to that date. While there were some levees as much as 4 feet higher than this flood, there were many miles overtopped and washed away by it. All the alluvial bottoms were overflowed, causing very great destruction not only to the levees but also to the property behind them, although the flood did not nearly reach the height that it would have attained if it had been confined between the levees. In their impoverished condition, with so much of their

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works swept away, and with their bonds and the interest on them remaining as a constant liability, and with a better conception of the great magnitude of the undertaking, the people were thoroughly discouraged. The Mississippi River Commission, however, began making allotments to aid in the construction of levees. These were small at first, but they gave the people hope and encouragement. They have increased from time to time as the levee question has become better understood, and found to be more and more involved in the problem of controlling the river and improving its navigation.

From 1865 to July, 1882, the Mississippi (Lower Yazoo) levee board expended $3,557,918.47.

Yardage in place after the flood of 1882, and before repair or rebuilding	6,278,728
Abandoned in 1882	310,002
Leaving available in 1882	5,968,726

Sketch of the Lower Yazoo levee district since 1882.—The following is a table of maximum gauge readings for the greater floods since 1876 at Cairo and important points along the district:

Year.	Cairo.	Mouth White River.	Arkansas City.	Greenville.	Lake Providence.	Vicksburg.
1876	46.38	46.7	45.5		37.95	44.9
1882	51.87	48.4	47.0	41.44	38.32	48.75
1883	52.17	48.0	46.32	40.40	36.47	43.80
1884	51.79	47.9	46.5	41.1	38.4	49.0
1886	50.98	48.2	46.9	41.17	37.91	44.15
1888	45.25	45.55	45.37	40.55	38.1	44.17
1890	48.8	50.4	49.3	43.4	40.3	49.0
1891	46.2	47.7	48.2	43.2	41.0	42.0
1892	48.3	49.3	50.0	44.2	41.9	48.4
1896	49.3	49.5	50.2	44.3	41.8	48.3
1897	51.7	52.4	51.9	46.75	44.5	52.48
1903	50.6	53.7	53.0	49.1	46.5	51.8

The result of the building of the levees in the Upper Yazoo district between 1884 and 1886 is shown by a study of the maximum gauge readings at mouth of White River for these years, while the effect of the closing of the gaps in the Arkansas levees between 1886 and 1888 is shown by a study of the gauge readings for these years at all the stations given.

In 1882 the whole district was overflowed, or an area of about 3,170 square miles more than would have been overflowed around the lower end of the present levee system. The same is true of the overflow from the flood of 1897. In 1890 about 1,900 square miles and in 1903 about 1,460 square miles were overflowed, or about 1,140 and 860 square miles, respectively, due to crevasses.

The grades after the flood of 1882 were to be the same as the adjacent levees, but nowhere less than the high water of that year, the average height for the whole system being about 2 feet above. Later, a grade of 3 feet above the highest known water was used until the flood of 1903, after which a provisional height of 2 feet above this flood was generally used in construction. The present adopted ultimate grade is 6 feet above the 1897 high water. Taking Greenville as an illustration, the changes in grade are shown as follows: 1882, 43.4; 1886, 44.2; 1888, 45.6; 1890, 46.4; 1892, 47.2; 1897, 49.8, and 1903, 51.1, or a total change of 7.7 feet in the twenty-one years. The Mississippi (Lower Yazoo) levee board instead of using 3 feet throughout these years used 4 feet above the 1888 and 5 feet above the 1891 floods, these being comparatively well confined and 3 feet above what it was figured that the flood of 1890 would have attained if there had been no crevasses. These grades did not differ very much from those used in the construction by the United States. Since 1893 levee construction by the local boards has been, in general, to the same grade as that under the Mississippi River Commission. From 1882 to 1888 a width of crown of only 2 feet was used in order to reach the necessary height of grade with the limited means at command. This width was found too weak and otherwise unsatisfactory, and a large amount of work was done in 1899 to give such levees a standard width of 8 feet, funds being provided from the proceeds of a loan negotiated for that purpose.

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The expenditures from July, 1882, to May 1, 1905, are as follows:

By the Mississippi levee board:	
For construction	$5,319,929.23
For rights of way, litigation, office expenses, high-water protection, etc	3,337,925.44
Total	8,657,854.67
By the United States:	
For construction	3,160,529.25
High-water protection, repairs, and engineering	530,853.42
Total	3,691,382.67

The total cost for levee work to date is $12,349,237.34, or about $65,500 per mile for the 188.6 miles of present effective levees in the district.

Upper Yazoo district.—The upper and back counties were organized into a levee district in 1884. It was called the "Yazoo-Mississippi Delta levee district," and still retains that name. It comprises the following counties: De Soto, Tunica, Tallahatchie, Panola, Quitman, Sunflower, Leflore, Yazoo, and Holmes.

Development of the country in Yazoo Delta from 1882 to 1905.—The following statistics show the growth of the country in the Yazoo-Mississippi Delta, which comprises all the country protected by levees in Mississippi:

Year.	Cotton crop.	Railroads.	Banks.	Oil mills.	Compresses.	Electric car lines.	Lumber mills.	Value of lands per acre.	
								Timber.	Cultivated.
	Bales.	*Miles.*				*Miles.*			
1882	185,000	41	1	1	0	0	0	$0.25–$1.00	$5.00–$10.00
1905	450,000	1,000	30	28	8	4	40	5.00–20.00	50.00–75.00

As a further example of the growth of the country, the following statistics for the city of Greenville are submitted:

Year.	Population.	Assessed value.	Banks.		Oil mills.		Waterworks.	Sewage system.	Street paving.	
			Number.	Capital and surplus.	Number.	Capital.			Miles.	Cost.
1882	3,000	$1,750,000	1	$150,000	1	$50,000	0	0	0	0
1904	10,420	4,900,000	4	600,000	4	900,000	$100,000	$120,000	1½	$135,000

Year.	Gas company.	Electric light.	Electric car lines.	Wholesale groceries, annual sales.	Compresses.	Packing company branches.	Ice plants, daily capacity.	Sawmills.	
								Number.	Capital.
							Tons.		
1882	0	0	0	0	0	0	4	1	$15,000
1904	$20,000	$150,000	$50,000	$2,500,000	$150,000	$40,000	100	4	80,000

By preventing the frequent recurrence of overflows, which so often flooded the country with vegetable mold, besides converting it into a disease-breeding swamp, and by enabling the inhabitants to clear and cultivate the land without being so often subject to the discomforts attending overflows, the levees have been the means of improving the healthfulness of the country.

Levee building in Louisiana and Arkansas prior to 1882.—Small levees were built by the first settlers as early as 1717 in the vicinity of New Orleans. With the development of the country on the right bank of the Mississippi the levees were enlarged and extended, so that in 1844 there was a continuous line from the lower limit of this district to the mouth of the Arkansas River. The grade of the levees was about 1 foot above the highest known water, making the average height about 4 feet. The base of the levee was generally made five times the height.

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The high water of 1844 broke the levees in many places. Between 1844 and 1850 but little attention was paid to keeping up the embankments, though some scattered work was done by individual planters.

By Congressional act of September 25, 1850, all Government lands in the overflowed sections of these States, as well as of Mississippi and Missouri, were transferred to the State authorities as a measure of assistance in maintaining the levee system. Some of the land was sold, and with the proceeds the entire line was put in fairly good condition south of Amos Bayou. During this period of reconstruction the rules in Arkansas were that the grade should be 30 inches above the highest known water, the base seven times the height, and the width of crown equal to the height.

The flood of 1858 washed away many miles of the line, and much additional damage resulted from the flood of the following year, which was nearly as great. After these floods the levees were in a ragged and broken condition, which was contributed to by the rapid caving of the banks. In this condition they remained until long after the close of the civil war.

Under the reconstruction régime Desha and Chicot counties in Arkansas were authorized to issue bonds to aid in the construction of a railroad, the embankment of which was to serve also as a levee. An indebtedness of $200,000 was thus incurred, but, through floods, mismanagement, and frauds, practically nothing was accomplished either in railroad or levee construction.

Some work was done from 1870 to 1882 by individuals working together, but it was not until after the establishment of the Mississippi River Commission in 1879 that local interests were organized into levee boards.

Levee building after 1882.—Beginning in 1882 allotments were made by the Mississippi River Commission for levees. In this district most of the construction work made by the Government was done in Arkansas on account of the importance of the upper end of the line to the large area of land below, the poor condition of these levees, and the inability of the local interests adjacent thereto to meet the situation. The Tensas Basin levee board, of Louisiana, has also contributed nearly all of its available funds to the construction and maintenance of the Arkansas line on account of the protection afforded by it to lands in that section.

In 1894 the jurisdiction of the Commission was extended to include the Arkansas River levee below Redfork, Ark. This line extends above Redfork to Pine Bluff, which section is maintained entirely by local interests. At the lower end there is a considerable gap between this and the Mississippi River line.

Local levee boards were organized as follows: Desha, Ark., in 1883; Chicot, Ark., in 1884; Tensas Basin, La., in 1886; Fifth Louisiana, in 1886, and Redfork, Ark., in 1891. A board of State engineers was instituted in Louisiana in 1879, which besides having charge of the direct expenditure of State funds for levee construction keeps in touch with and advises the various levee boards of the State.

The very considerable floods of 1898 and 1904 were passed without any breaks in the levees. In the flood of 1882 there were many breaks and the area overflowed was 3,000 square miles; in that of 1890 there were 17 crevasses and the overflowed area was 2,500 square miles; in that of 1897 there were 3 crevasses and the area overflowed was 1,030 square miles; and in that of 1903 there was 1 crevasse, the area overflowed being 1,300 square miles. After each flood the crevasses were promptly closed, the height and section of the embankments increased, and every effort made to so strengthen the system as to safely pass recurring floods.

The floods of 1890, 1891, 1892, and 1893 demonstrated that it would be best to abandon the old Arkansas levees, their foundations and construction having been shown to be so bad that it would be poor policy to place upon them the necessary enlargements. A new and more retired line was adopted and the rebuilding progressed until there now remains only a few thousand feet on the old location.

Efforts are now being directed toward raising the entire line at least 2 feet above the high water of 1903. In Louisiana this has been fully attained, and in Arkansas it will be attained probably next year. The average height of the embankment has increased during recent years so as to maintain about the same grades as have been given under the Lower Yazoo levee district. An ultimate grade of 6 feet above the 1897 high water was tentatively adopted by the Commission in 1898, but it may require some modifications in view of the heights which were reached by the flood of 1903 and the height which may be reached by future floods.

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Expenditures in the Upper Tensas district from 1882 to May 1, 1905.

By the United States:	
For construction	$4,006,380.19
For high water protection, repairs, engineering, etc	814,476.89
Total	4,820,857.08
By levee boards:	
For construction and maintenance	[a]3,209,796.43
Total	8,030,653.51

This shows a cost of about $42,250 per mile for the 190.2 miles of effective levee now in the system.

The following comparative statistics will show the development of the country since the beginning of the present system of levees, in 1882:

Year.	Banks.	Railroads.	Oil mills.	Sawmills.	Ice plants.	Artesian wells.	Telephone lines.	Value of lands per acre.	
								Timber.	Cultivated.
		Miles.					*Miles.*		
1882	1	106	1	10	0	0	0	$0.25 to $1.00	$5.00 to $10.00
1905	14	565	7	40	4	10	Many.	5.00 to 20.00	50.00 to 75.00

Year.	Street paving.		Electric light plants.	Wholesale groceries.	Compresses.	Packing company branches.	Telegraph lines.
	Miles.	Cost.					
							Miles.
1882	0	0	0	0	0	0	106
1905	2	$150,000	5	2	4	4	565

SECTION II.—REPORT ON LEVEE WORK FOR FISCAL YEAR.

Lower Yazoo levee district (365 to 592 L.).—(For description and history see summary herewith, and reports of the Mississippi River Commission since 1882.) This district has a continuous levee line 188.6 miles long to Eagle Lake (584 L.). Its construction to the mouth of the Yazoo River will involve an extension of about 14 miles, and when completed it will protect an area of 3,367 square miles.

At the beginning of the year all but three of the 1903–4 contracts had been completed; there still remaining to be placed 196,045 cubic yards. Under an allotment of $150,000 ($50,000 reallotted to revetment at Longwood), from appropriations of April 28, 1904, for fiscal year 1905, one contract was made for placing 344,797 cubic yards of enlargement and topping. In addition an informal contract was made for 1,594 cubic yards of subbanquette. All uncompleted 1903–4 contracts and 1904–5 contracts have been completed during the year.

Under allotment of $150,000 from appropriation of April 28, 1904, for fiscal year 1906, two contracts were made for placing 621,888 cubic yards of new work and enlargement, thereby anticipating expenditure of funds for this fiscal year; there remains to be placed 82,072 cubic yards to complete. As funds would not be available for this work until July 1, 1905, the contractors have made arrangements with various parties for cashing their monthly estimates, and the Mississippi levee board, as per agreement previous to the letting of the work, has paid the discounts, thereby insuring to the contractor the full amount of the estimates.

The average cost of levee construction this year was 17.3 cents per cubic yard.

Minor contracts were made for repair work, weed cutting, etc., which have been completed. Expenditures on this account were $8,191.21, paid by the United States, plus $4,751.30 paid by the Mississippi levee board.

The levee board placed 4,246,661 cubic yards during the year, being enabled to do this large amount of work by the specially authorized sale of $1,000,000 worth of bonds.

[a] This is exclusive of costs of rights of way, litigation, office expenses, etc., of which no complete record is available.

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Summary of earth in place.

		Cu. yards.
In place April 30, 1904		35,615,386
Added by the United States	1,040,708	
Added by levee board	4,246,661	
	5,287,369	
Lost and abandoned	2,997,000	
		2,290,369
In place April 30, 1905		37,905,755

Required to complete to Commission grade and section, about 12,000,000 cubic yards, at an estimated cost of $2,400,000. (For details see report of Assistant Engineer E. C. Tollinger, Appendix 3 C, herewith.)

Upper Tensas levee district (402 to 606 R.).—(For description and history see summary herewith and reports of the Mississippi River Commission since 1882.) The levees in this district consist of two lines—one 17.5 miles long, being an extension of the Arkansas River levee below Redfork, Ark., and the other, 172.7 miles long, being the Mississippi River levee, which begins on comparatively high ground at Costello's gin, extends in a southeasterly direction to the bank of the river, thence along the right bank of the river to the limit of the district at Warrenton. The total length of levee line is 190.2 miles.

At the beginning of the year there were no uncompleted 1903–4 contracts. Under an allotment of $230,000 from appropriation of April 28, 1904, for the fiscal year 1905, three contracts were made for the placing of 928,388 cubic yards of new and enlargement work; of this amount there still remains 49,116 cubic yards to be placed.

Under allotment of $230,000 from appropriation of April 28, 1904, for the fiscal year 1906, four contracts were made for placing 1,133,772 cubic yards, thus anticipating the expenditure of funds for this fiscal year. As funds would not be available for this work until July 1, 1905, the contractors made arrangements with various parties for discounting their estimates, the local levee boards having agreed previous to the letting to pay the discount, thus insuring to the contractors the full value of their estimates. There still remain to be placed under these contracts 337,747 cubic yards.

The average cost of levee constructed this year was 20.1 cents per cubic yard.

Repairs have been made by day labor on levees damaged by rain and wave wash, and a few minor repairs have been made on spurs and road crossings. Material placed, 28,671 cubic yards, at a cost of $7,177.50, or an average per unit of 25 cents. Weed cutting in Louisiana was undertaken by the Fifth Louisiana levee board; in Arkansas but little was necessary, as the levees are generally well sodded and pastured. Expenditures, $624.93 for cutting 1,779.7 stations; average cost per station, 35.1 cents. Number of station resodded, 280, at a cost of $451.96.

Total expenditures for repairs, weed cutting, and resodding, $8,254.39.

The local levee boards did the following work:

	Cu. yards.
Redfork	0
Desha	10,334
Chicot	0
Tensas Basin	130,002
Fifth Louisiana	520,147
Total	660,483

Summary of earth in place.

		Cu. yards.
In place April 30, 1904		30,784,126
Added by the United States	1,675,297	
Added by levee boards	660,483	
	2,335,780	
Lost and abandoned	653,600	
		1,682,180
In place April 30, 1905		32,466,306

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Required to complete to Commission grade, about 16,532,000 cubic yards, at an estimated cost of $3,306,400. (For details see report of Assistant Engineer A. M. Todd, Appendix 3 D, herewith.)

Levee work generally.—The immediate object in view in this district is the construction of the levees to a height of 2 feet above the high water of 1903. To fully accomplish this in the next couple of years some sacrifice in section will be necessary and is being made by the use of topping. Some of the topping placed during the year was only a small bank of earth, with a 2-foot crown or less and as steep slopes as possible, which is of little use except as an important preparation for a high-water fight. The continued use of topping is contemplated this year, but only where the levee is of good material, standard slopes, and well protected from wave wash; the crown is to be 4 feet wide, front slope 1 to 2, and back slope 1 to 3 in prolongation of the levee back slope, thus giving what in reality is an enlargement of reduced section. By complying with the above rules it is hoped and believed that such work will be all sufficient until the final enlargement of the levee to full Commission grade and section is undertaken. (See maps Nos. 14 and 15 herewith for comparison of present height of levee with flood height.)

A certain and substantial reduction of the overflowed area may be effected by the extension of the Mississippi levee toward the mouth of the Yazoo, and of the Arkansas River levee toward Cypress Creek; the latter should be extended, at least to the high ground, soon, the end at present being in a low swamp.

Extended study has been given to the effects of flow across points during floods and to the results to be obtained if spur levees should be built to cut off such flow and force it around the main channel of the river. A special report on this subject has been submitted by the board of district officers in connection with their report on levee grades and alignment.

Especially favorable conditions for this study were presented in the Arkansas City-Greenville reach, where, in 1903, the quantity and extent of across-point flow was greatly increased over former floods by the failure of the Huntington Point levee, the unprecedented high water, and the washing away of the old levee on Leland Neck. It is estimated that at Huntington and Leland about one-fourth of the entire flood was abstracted from the main channel, poured violently across the necks, and was again added to the main flow below with such velocity and direction as to produce great disturbance thereto. Great quantities of water also flowed across the three other points between Huntington and Leland. The abnormal height reached at Greenville was naturally ascribed to this unusual across-point flow—a view that is sustained by the fact that up to and considerably above a bank-full stage the Greenville gauge reading increases uniformly with that of Arkansas City. A further proof is had in the effect of the spur built on Leland Neck, to which is ascribed a relatively lower gauge reading at Greenville of about 1 foot in the flood of 1904. Further study will be given to this important subject which, if all the indications are substantiated, may make it advisable to construct spurs on some or all of these necks rather than increase the ultimate levee grades below at much greater expense.

Caving banks.—Continued observations and surveys have been made of caving banks which threatened cut-offs or endangered the levees. The only situations that will probably necessitate expenditures in the near future are Chicot front (430–432 R.), Longwood (502 L.), and Fitlers (551 L.). It is expected that the levee board will do any work required at Longwood and Fitlers. At Chicot the bank, though close to the levee, is chipping very slowly, and the flat under-water slope of 1 to 10 indicates that an increased rate is not probable. Work here may not be required for several seasons, if at all.

High-water operations.—At the beginning of the year the river was still above the danger line, but high-water work had been suspended, except for a small party which continued maintaining the end of Leland Spur. The expenditure amounted to $370.13. To date this spring the water has reached a stage of but 39.8 feet at Arkansas City—more than 2 feet below the danger line; its only damaging effect has been from suspension of work on uncompleted contracts on account of the flooding of the borrow pits.

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INCLOSURES.

The following inclosures accompany this report, of which they are parts:

Money statements, abstracts of contracts in force, abstracts of proposals, and list of civilian engineers will be forwarded July 1.

Appendix 3 A.—Report of Assistant Engineer Arthur Hider on bank revetment.

Appendix 3 B.—Report of Junior Engineer L. Y. Kerr on surveys.

Appendix 3 C.—Report of Assistant Engineer E. C. Tollinger on levees, Lower Yazoo levee district.

Appendix 3 D.—Report of Assistant Engineer A. M. Todd on levees, Upper Tensas levee district.

Map No. 1. Index map, third district.
Map No. 2. Lake Bolivar revetment.
Map No. 3. Ashbrook Neck revetment.
Map No. 4. Greenville Harbor revetment.
Map No. 5. Longwood revetment.
Map No. 6. Louisiana Bend revetment.
Map No. 7. Lake Providence revetment.
Map No. 8. Delta Point revetment.
Map No. 9. Greenville reach.
Map No. 10. Kentucky Bend.
Map No. 11. Lake Providence reach.
Map No. 12. Lake Providence Bend.
Map No. 13. Delta Point reach.
Map No. 14. Profile of levee, Lower Yazoo district.
Map No. 15. Profile of levee, Upper Tensas district.

Very respectfully, your obedient servant,

G. M. HOFFMAN,
Captain, Corps of Engineers.

Col. O. H. ERNST,
Corps of Engineers, U. S. Army,
President Mississippi River Commission.

FINANCIAL STATEMENT.

Appropriation for improving Mississippi River, third district.

LAKE BOLIVAR FRONT.

Amount allotted from appropriation for improving Mississippi River, act approved March 3, 1905	$50,000.00
July 1, 1905, balance unexpended and available	50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1907	10,000.00

ASHBROOK NECK.

July 1, 1904, balance unexpended	15.01
June 30, 1905, amount expended during fiscal year	14.58
July 1, 1905, balance unexpended	.43
July 1, 1905, outstanding liabilities	.43
Amount that can be profitably expended in fiscal year ending June 30, 1907	10,000.00

GREENVILLE, MISS.

July 1, 1904, balance unexpended	180.32
June 30, 1905, amount expended during fiscal year	180.15
July 1, 1905, balance unexpended	.17
July 1, 1905, outstanding liabilities	.17
Amount that can be profitably expended in fiscal year ending June 30, 1907	30,000.00

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LONGWOOD, MISS.

Amounts allotted from appropriation for improving Mississippi River, acts approved April 28, 1904, and March 3, 1905	$185,000.00
June 30, 1905, amount expended during fiscal year	146,790.43
July 1, 1905, balance unexpended	38,209.57
July 1, 1905, outstanding liabilities	100.00
July 1, 1905, balance available	38,109.57
Amount that can be profitably expended in fiscal year ending June 30, 1907	10,000.00

LAKE PROVIDENCE REACH.

July 1, 1904, balance unexpended	38.75
June 30, 1905, amount expended during fiscal year	38.35
July 1, 1905, balance unexpended	.40
July 1, 1905, outstanding liabilities	.40
Amount that can be profitably expended in fiscal year ending June 30, 1907	30,000.00

REPAIRS TO REVETMENT AT LAKE PROVIDENCE, AND GENERAL REPAIRS, INCLUDING QUARRYING OF STONE.

Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904		67,000.00
June 30, 1905, amount expended during fiscal year, account different works, as follows:		
Ashbrook Neck	$3,685.87	
Greenville, Miss	4,590.07	
Lake Providence reach	33,120.29	
Surveys, third district	251.80	
		41,648.03
July 1, 1905, balance unexpended		25,351.97
July 1, 1905, outstanding liabilities		1,500.00
July 1, 1905, balance available		23,851.97
Amount that can be profitably expended in fiscal year ending June 30, 1907		50,000.00

STONE, THIRD DISTRICT.

July 1, 1904, balance unexpended	1,768.26
June 30, 1905, amount expended during fiscal year	598.42
July 1, 1905, balance unexpended	1,169.84
July 1, 1905, outstanding liabilities	50.00
July 1, 1905, balance available	1,119.84
Amount that can be profitably expended in fiscal year ending June 30, 1907	40,000.00

PLANT, THIRD DISTRICT.

July 1, 1904, balance unexpended	[a] 33,446.33

[a] Amount increased $1.14, due to refundments on account of overpayments pertaining to fiscal year 1904.

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Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904		$20,000.00
Amount allotted during fiscal year 1905, being proceeds of sale of public property		1,699.95
		55,146.28
June 30, 1905, amount expended during fiscal year		54,355.40
July 1, 1905, balance unexpended		790.88
July 1, 1905, outstanding liabilities		790.88
Amount that can be profitably expended in fiscal year ending June 30, 1907		65,000.00

SURVEYS, THIRD DISTRICT.

July 1, 1904, balance unexpended		.60
Amount allotted from appropriation for improving Mississippi River, act approved April 28, 1904		5,000.00
		5,000.60
June 30, 1905, amount expended during fiscal year		5,000.33
July 1, 1905, balance unexpended		.27
July 1, 1905, outstanding liabilities		.27
Amount that can be profitably expended in fiscal year ending June 30, 1907		6,000.00

LOWER YAZOO LEVEE DISTRICT.

July 1, 1904, balance unexpended		44,987.08
Amounts allotted from appropriations for improving Mississippi River, acts approved April 28, 1904, and March 3, 1905		225,000.00
August 24, 1904, amount deposited in Treasury of the United States to credit of the allotment by Solicitor of the Treasury; being amount collected from bondsmen of Thomas Worthington, contractor		1,032.28
		271,019.36
Amount transferred to first and second districts during fiscal year	$7,500.00	
June 30, 1905, amount expended during fiscal year	127,006.45	
		134,506.45
July 1, 1905, balance unexpended		136,512.91
July 1, 1905, outstanding liabilities		2,000.00
July 1, 1905, balance available		134,512.91
Amount that can be profitably expended in fiscal year ending June 30, 1907		500,000.00

UPPER TENSAS LEVEE DISTRICT.

July 1, 1904, balance unexpended		[a]17,237.60
Amounts allotted from appropriations for improving Mississippi River, acts approved April 28, 1904, and March 3, 1905		340,000.00
		357,237.60
Amount transferred to first and second districts during fiscal year	$7,500.00	
June 30, 1905, amount expended during fiscal year	224,492.87	
		231,992.87

[a] Amount increased by 70 cents, due to refundment on account of overpayments pertaining to fiscal year 1904.

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July 1, 1905, balance unexpended	$125,244.73
July 1, 1905, outstanding liabilities	2,500.00
July 1, 1905, balance available	122,744.73
July 1, 1905, amount covered by uncompleted contracts	13,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1907	500,000.00

Abstract of contracts in force June 30, 1905, third district, improving Mississippi River.

[Levee work in Upper Tensas levee district.]

Name of contractor.	Station.	Cubic yards.	Rate per cubic yard.	Date of approval.	Date of beginning.	Date of expiration.
			Cents.			
Cary Bros	0- 500	200,000	15	Sept. 12, 1904	Aug. 16, 1904	[a] Mar. 1, 1905
McCadden, Morgan & Co	788- 833	480,000	19.5	do	Sept. 8, 1904	Do.[a]
	833- 883					
	883- 926					
Ben Talley & Co	2580-3760	230,000	20	June 7, 1904	June 6, 1904	[a] Jan. 31, 1905
	3760-3960					
	1539-1810	100,000	18.5			

[a] Time limit waived.

APPENDIX 3 A.

REPORT OF MR. ARTHUR HIDER, ASSISTANT ENGINEER, ON CONSTRUCTION WORK, CARE AND REPAIRS TO PLANT, AND QUARRYING AND TOWING STONE, IN THE THIRD DISTRICT, FOR THE SEASON OF 1904–5.

GREENVILLE, MISS., *May 1, 1905.*

CAPTAIN: I have the honor to submit the following report on construction work, care and repairs to plant, and quarrying and towing stone, in the third district, from May 1, 1904, to May 1, 1905.

CONDITION OF REVETMENTS.

Lake Bolivar revetment (417 L.).—The change in the river channel above has induced a more direct attack on this work than in former years, and has destroyed by caving a portion of the lower end of the old work, which was constructed of the old style of woven mat in 1888–89. No repair work was done the past season. It is recommended that 2,000 linear feet of standard fascine mat be sunk along the old work as a reenforcement. Should the upper bank remain intact and not need regrading, the estimated cost of this work is $50,000. Should the upper bank slough to any great extent before this work is done, requiring regrading and repaving, this cost will be exceeded. However, from present indications it is probable that the amount specified above will be sufficient for the length of reenforcement work as recommended above.

Ashbrook Neck revetment (446 L.).—The work last season consisted in the repairs to three small breaks in the upper revetment, stations 110–112 and stations 10–14.

The length of the mattress work, which is the old style of woven mat constructed in 1890, that needs reenforcing, is 2,000 feet, located between stations 103–93 and 5–15. This work should be done the coming season, as the expense of the work if completed before the upper bank slope is destroyed will not exceed 50 per cent of what it would be if the bank should cave back, necessitating the regrading and repaving of the entire slope. The above remark applies with equal force to other places where reenforcing work is required.

It is believed that a great part of the sloughing at different points along the upper revetment which has taken place within the last ten years could have been prevented by draining the low ground in the rear of this work, so that the impounded water would enter the river on the lower side of the neck. The cost

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of excavating a ditch for this purpose would, it is believed, be fully justified by the results obtained.

To build 2,000 linear feet of reenforcing work with standard woven mat 250 feet wide is estimated will cost approximately $17.50 per linear foot. Allowing for some slight slips in the upper bank, which will probably occur during the coming low-water season, this will amount to $35,000.

Should this full amount not be available, it is recommended that the reenforcing work be done between stations 92 and 104, so as to make the reenforcing mat work continuous from the head of the work, as the repairs required have been more extensive in this section, showing the greater need of the subaqueous mat being renewed.

The cost of the repairs made last season was as follows:

213 squares of mat, at 8.46+	$1,849.24
405 linear feet hand grading, at $2.48+	1,005.65
42 squares brush revetment, at $13.81+	580.23
197 squares paving, at $5.06+	1,000.58
Minor repairs to paving along the revetment	258.66
Towing	164.50
Miscellaneous charges	83.25
Total	4,942.11

On account of the lateness of the season and the resultant bad weather and interruptions from ice, these repairs were not as thorough as desired, and at the same time more expensive than usual on account of loss of time from the above causes. This work was begun January 26 and completed February 22.

Greenville Harbor (478 L.).—The repairs made last season consisted of small pocket mats, stations 29–32 and 76–80. In the first instance the upper slope was undoubtedly destroyed by insufficient drainage having been provided for the impounded water left between the main levee when enlarged by excavating material between the new and the abandoned levee in front.

As the river fell below the bank, this allowed the impounded water to seep through the slope at a point where the material is of such character as to flow like quicksand when saturated, undermining the paving and destroying the slope, which continued to cave back until the impounded water above the level of the bank was discharged.

The second slip, which was at the foot of Main street, is believed to be due to the saturation of the upper bank by emptying the city slops down the slope. This part of the front has been used by the city for several years past as a dump for offal, garbage, and slops. Since the repairs have been made, this has been abandoned and the offal, garbage, etc., disposed of elsewhere. An unexpected break occurred March 19 between stations 37+75 and 40+34. The outlet or discharge of the city sewerage system is located at station 40. The sewage is discharged through a 12-inch iron pipe laid down the slope of the revetment, the end of which extended to about 3 feet above low water. Immediately over this pipe the city had erected a concrete trough to carry the city slops over the revetment into the river. This had never been put in use and could have had no part in causing the break.

The first indications of caving were observed immediately in front of where the sewage discharge pipe is located. This caving extended rapidly upstream, due to the strong eddy action at this point at the time, the river being at bank-full stage, until about 260 feet of the upper slope was destroyed. This occurred within an hour, and since then no material change has taken place. A survey was made which showed that at station 40 the subaqueous mat was intact up to the 10-foot stage on the slope. Between this and the top of the bank a hole had been scoured out to a depth of 3 feet below the zero of the gauge.

The average distance caved back along the upper bank at the time of the survey was about 35 feet. This has increased slightly since and may be expected to enlarge as the water falls. From an examination of the sections as shown by the survey, and from the fact that the break first showed at the discharge pipe, it is believed that the cave was started by a fracture or settling of the pipe, allowing the sewage to undermine the riprap, and that, when the hole once started, it rapidly extended upstream, due to the strong eddy action.

When the break is repaired, the city authorities intend to arrange the sewer outlet so that no trouble from that cause will arise in the future.

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estimated that at least 500 linear feet of new work will be required at
nt to restore the revetment to its former condition, which, at $35 per
t, estimated, will cost $17,500.
ir work was done by part of the force transferred from Longwood
at work at that point was finished, beginning work at Greenville
13 and finishing the mat work January 25, when this party was
Ashbrook Neck to make the necessary repairs at that point, a
borers finishing the regrading and riprap work. This was com-
21.
ne repairs was as follows:

of mat work, at $4.14—	$3,075.76
r feet hand grading, at $0.72+	382.34
quares of paving, at $4.10+	2,844.97
utting ditches	676.44
Miscellaneous charges	23.70
Total	7,003.21

Longwood revetment (500 L.).—The construction of this revetment was for the purpose of protecting the large and important levee immediately in the rear, which was threatened by the rapid caving of the bank which had been in progress for several years past and had approached dangerously near to the levee.

The shortest practical line for a new levee was estimated at $700,000, exclusive of rights of way and property damages.

The original project called for the construction of 5,000 feet of standard revetment mattress 300 feet wide. Under instructions of the officer in charge the width of the mats was reduced, after three mats had been placed, to 250 feet, above and below, as that portion of the bank where the principal force of the current impinged was well protected by the wider mats. Work was begun September 1, 1904, and completed February 16, 1905. A total length of 4,200 feet was constructed.

The work as completed extends from the point where active caving was in progress at the upper end of the bend, to a point well below the deepest part. Caving is still in progress below the work, extending for a considerable distance down. The material, however, is such as to better resist the erosion of the current, being the bed of an old cypress brake. In order to finish this revetment, it will probably be advisable to extend it 1,000 feet farther down; beyond this, if necessary, a new location for the main levee can be found, should it be threatened, at a reasonable cost.

The bank in front of the revetment was grown up with a dense growth of cottonwood and willow and covered by a deep deposit from the previous high waters, as the bank itself is considerably lower than the usual height, and at high water the main current of the river passes on the opposite side of the middle bar and renders the current slack along the front of the revetment, the most active caving taking place at the lower stages of water, when the main channel was in the bend.

Clearing.—The bank for a considerable distance back was cleared of all standing brush and timber, and such as was suitable and could be handled at reasonable expense was used in the work; 10.6 acres were cleared.

Bank grading.—The hydraulic grader began work October 1, it being necessary to build and sink a mattress to hold the bottom of the slope before grading could begin. The upper 600 feet was pure sand, and the lower 3,600 feet was composed of a mixture of loam, sand, and buckshot in varying proportions. But little trouble in grading was encountered in the lower portion, but where the bank was of pure sand it gullied badly and caved even after the mats were in place.

The approximate slope of the graded bank was 3 on 1, and contained on an average about 30 yards to a linear foot, making the quantity of earth removed by the grader 135,000 cubic yards, or $0.0379 per cubic yard.

Four thousand five hundred linear feet of bank was graded, at a cost of $1.137 per linear foot, to which is to be added the cost of trimming up with shovels, $0.534, making the total cost per linear foot of the bank graded $1.671.

The grader was built in 1881 and has been in use every season since. The cylinders of the pumps are cracked and not safe to carry the high pressure for which they were originally designed, and consequently are not as efficient as desired. It is suggested that a 3 or 4 stage centrifugal pump be installed, capable of working at a pump pressure of 200 pounds, as an auxiliary; this

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stream to be used as a cutting stream, which would be of great advantage, especially in sandy banks, removing the material with a much smaller quantity of water than by using a less nozzle velocity.

Mattress construction.—Six channel mats were constructed.

	Squares.
No. 1, 964 by 300	2,892
No. 2, 768 by 300	2,304
No. 3, 520 by 300	1,560
No. 4, 743 by 250	1,857.5
No. 5, 1,016 by 250	2,540
No. 6, 616 by 250	1,540
Total (4,627 linear feet)	12,693.5

Nine pocket or connecting mats were built of varying sizes to connect the main mats with the upper bank; the large number necessary was due to the constant caving in progress during the time the main mats were being constructed.

The dimensions of these mats are as follows:

Pocket mat:	Squares.
No. 1	135
No. 2	293
No. 3	228
No. 4	220
No. 5	69
No. 6	174
No. 7	138
No. 8	68
No. 9	100
Total pocket mats	1,425

Total squares of mat constructed, 14,108.5. Part of mat No. 1 was lost in sinking. This mat was 964 by 300 feet, part of which was sunk during a stationary stage of water and a current velocity of 5½ feet per second in a depth of water varying from 65 to 70 feet along the outside of the mat. The mat was secured to the shore by 15 1-inch steel cables at the head, and the two mooring barges had 7 new 2-inch manila lines—more than the usual number, both of cables and lines. While in the process of sinking, after about 400 feet had been submerged and the head of the mat in position on the bottom, without warning the outside 2-inch line on the outer mooring barge parted near the fastening on shore and then the other lines holding the mooring barges parted one by one as the extra strain came upon them releasing the mooring barges to which the stone barges were attached, the whole floating downstream over the mat. Unfortunately, in endeavoring to get the stone barges back into position to complete the sinking, a loose line became entangled in the wheel of the tug and she became helpless, floating downstream with the stone barges that had broken loose. Before the steamboat, which was half a mile below engaged in landing the mooring barges, could return, the mat in its half-submerged position, swaying up and down by the force of the current, began tearing from the outer edge inshore. It then tore entirely loose and drifted downstream, finally lodging in the chute about 4 miles below the work.

A careful survey over the mat showed that the break began 530 feet from the head and tore diagonally across toward the inner edge at the foot, where it parted 715 feet from the head. The effective part of this mat was 530 feet in length and the loss 434 feet.

The primary cause of the loss of this mat is believed to be due to some one or more of the following:

First. Parting of the outside mooring line.

Second. Insufficient force of labor.

Third. Too light ballasting for the force employed in sinking.

The outside line on the mooring barge which first parted broke almost square off, showing a poor quality of the fiber of the rope. A portion of this line was sent for test to Professor Spaulding, of the University of Missouri, and he reports the breaking of the test piece at a pull of 18,000 and 21,000 pounds in the two tests; the highest limit being about two-thirds of the strength called for by the specifications. On an examination of the mooring barges it was found

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that the excessive strain thrown on the timberheads, one by one, had caused two of the timberheads on the inside barge to show signs of falling by the bolts near the bottom pulling partially through the wood, allowing the top to tip forward.

These barges were old—built in 1888—and repaired and strengthened for the work. In order to take no further risks, two of the new barges were used afterwards in their place as mooring barges.

Great difficulty was experienced in keeping a sufficient force of labor during the latter part of September and early part of October, due to the fact that a great number of negroes had left for the cotton fields. The force of laborers during this period averaged only from 75 to 80 men. The day the mat was sunk, only 75 laborers were on the work—a force entirely inadequate to sink a mat of this size.

On account of the scarcity of labor and the fact that a circus was billed in the neighborhood, which would still further deplete the number, an effort was made to get the mat ballasted and sunk, if possible, before the circus, as from former experience nearly every negro would be absent. The mat had been nearly a month in building. It was begun on the 3d and finished on the 28th of September, and had shown signs of sinking in places, due to the deposit of sediment on account of the length of time it had lain in the water, and for this reason was not so heavily ballasted as usual. Any one of the causes enumerated above would be sufficient to make the successful sinking uncertain. Had there been a force of 150 men, the mat doubtless would have been successfully sunk.

Paving.—This work was begun October 17, 1904, and completed February 16, 1905, using such men as could be spared from mat construction.

Part of the upper bank was paved with flat stone laid on the graded bank, and part had a course of from 3 to 4 inches of spalls as a foundation. As these different kinds of paving are distributed in patches of 200 to 1,200 feet in length along the revetment, this will give an opportunity of fairly judging the relative merits of both methods compared with the cost. The cost per square with riprap alone was $5.52; with spalls and stone, $7.80.

Drainage.—Surface drains were cut along the top of the bank to prevent the water from heavy rains flowing down the slope where the material was light. A large ditch was excavated at the lower end for the purpose of draining the borrow pits which contained a considerable depth of water. The emptying of the borrow pits seemed to have a good effect in decreasing the caving, which was going on more or less during the whole time of construction. A second ditch should be dug above the head of the work in order to keep these pits free of water.

Towing.—This work was done by the steamers *Arthur Hider* and *H. St. L. Coppee*, the latter boat, with a single crew being employed principally in harbor work, while the other boat, with a double crew, was engaged in towing material for the different works.

The steamer *Arthur Hider* was put in service September 1, 1904, and operated with a single crew until October 20, when the crew was doubled for night service.

The new steamer *H. St. L. Coppee* was put in service October 20, 1904, at Longwood, transferred to Lake Providence February 20, 1905, and again transferred to levees on completion of the revetment work March 1, 1905. The steamer *Arthur Hider* was retained in commission until the last of the plant obtained from the first district had been returned to Memphis, when the boat returned to Greenville and was laid up with the fleet March 3.

Material.—Brush and poles were furnished under contract by Hunter & Frey. Stone was procured under contract from J. J. Ball & Co., of Little Rock, Ark., delivered on the bank at Arkansas City; and from Chas. J. Menges, of Rosiclare, Ill., on barges, delivered at Longwood, supplemented from the reserve at Greenville, Miss.

The supply of material of all kinds was fully up to the demands, except at the close of the work at Longwood, when a slight delay was experienced on account of the tow being delayed by ice.

Lake Providence revetment (517 R.).—The following from the report of Supt. George C. Thomas, who had charge of these repairs, gives a description of the work done:

"The damage sustained by this work since the close of the previous season's operations consisted of three small breaks in the upper slope, stations 20–22; 62–65; 66–68, and another of considerable extent, stations 33–40.

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"This entire damage was apparently due to the indiscriminate passage of surface water over the slope, the drains originally provided for taking care of this water having been closed by deposit from the annual overflows.

"Operations were begun January 1, 1905, by the first district mat party, transferred from Longwood, Miss., for the purpose. Connecting mats lapping the original subaqueous work were constructed and sunk in each pocket, and the upper bank resloped and paved.

"Surface drains were constructed where necessary and arrangements made with the local levee board for draining the extensive borrow pits behind the lower portion of the work. Considerable delay was experienced in the prosecution of this work on account of an epidemic of smallpox, which caused a temporary suspension of operations from February 1 to 15, the work finally being completed by the original Longwood revetment party, which was transferred to Providence February 20.

"Harbor work and towing were done by the steamers *Arthur Hider* and *H. St. L. Coppee*, the former boat, after returning the first district outfit to Memphis, being laid up with the fleet, and the *Coppee* transferred to levees March 1.

"The annual low-water survey shows but little change in the condition of the subaqueous work from that of the previous season, excepting from stations 22 to 26, where considerable scour has taken place underneath the mat reducing the slope to about 2½ on 1.

"The Benham bar extends well down below the head of the work, showing dry on a zero stage as far down as range 100. This thoroughly shields the upper 4,000 feet of the work and transfers the attack to about the center of the reach.

"As the lower half of this reach was revetted ten years ago and with old-style woven mats, it is important that it be reenforced with 250-foot fascine mats during the coming season, to enable it to withstand the attack to which it must be subjected until changes in progress transfer it below the salient at range 20, of which there is no immediate prospect.

"Close attention should be given to the drainage of this work. The annual high water, if above a bank-full stage, will close all surface drains, force the water over at points not specially prepared for it, and result in the usual damage to the upper slope.

"This work was completed February 25, the force disbanded, and the outfit transferred to fleet at Greenville."

Cost of repairs.

2,256.8 squares pocket mat, at $6.26+	$14,138.43
1,125 linear feet hydraulic grading at $1.12+	1,261.08
180 linear feet hand grading, at $1.54+	277.71
825 squares of paving, at $7.70—	6,350.62
Drainage	346.31
Towing	6,695.94
Miscellaneous charges	2,585.92
Total expenditures	31,656.01

QUARRYING AND LOADING STONE.

The force at the quarry was disbanded May 25, 1904. The quarry has not been operated since on account of the unusual low-water season not affording boating stage in Little Red River of sufficient length to admit of stone being towed economically.

Summary of cost of quarrying, towing, and unloading stone, 1904.

Month.	Cubic yards quarried.	Cubic yards loaded.	Cubic yards towed.	Cubic yards unloaded.	Cost to quarry and load.	Cost to tow.	Cost to unload.	Total.
February	2,000				$2,184.74			$2,184.74
March	6,000	1,650			3,890.40	$1,139.82		5,030.22
April	2,630	4,960	4,361.3	2,204.9	3,683.69	2,009.32	$405.06	6,098.07
May	2,370	4,746.4	7,015.1	3,359.9	4,007.08	3,034.84	552.55	7,594.47
Total	13,000	11,376.4	11,376.4	5,564.8	13,765.91	6,183.78	957.61	20,907.30

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Of the above amount expended there was paid by the Mississippi levee board $11,009.54 for stone to be used on Longwood revetment.

In the above statement there is included the cost of quarrying about 1,700 cubic yards of stone now at the quarry ready to load, and 1,200 linear feet of face drilled ahead ready for blasting.

	Per cu. yd.
Cost to quarry and load	$1.21
Cost to tow	.5436
Cost to unload	.172
Total	1.9256

From the total amount, 5,564.8 cubic yards there has been reloaded on barges and used on revetments 3,874.1 cubic yards. This was loaded at a cost of $0.3557 per cubic yard. The average cost on barges of the stone actually used was $1.953 per cubic yard, as a large quantity, 5,811.6 cubic yards, was held on barges and did not require rehandling.

In addition to the above, riprap and spalls were purchased under contract, as follows:

J. J. Ball & Co., 15,139.56 cubic yards, delivered on bank at Arkansas City, at $1.55 per cubic yard.

Chas. J. Menges, 4,125.96 cubic yards, delivered on barges at Longwood, for $1.75 per cubic yard.

The stone furnished by J. J. Ball & Co. was loaded on barges by the United States, at a cost of $0.39948 per cubic yard, making a total cost of $1.95 per cubic yard on barges. The stone was loaded by carts and wheelbarrows.

The delivery of stone at this point was not sufficient to meet the demands of the work, and it became necessary to move the cart force to Greenville to load from the reserve at that point, leaving the wheelbarrow force to load at Arkansas City. This, together with the scarcity of labor, the increase of 25 cents per day paid for labor above previous seasons, and the unusual amount of bad weather, added materially to the cost. A comparison of cost of the methods of loading is given below:

How loaded.	Cubic yards loaded.	Cost.	Cost per cubic yard.
By carts	7,210.00	$2,428.95	$0.3368
By wheelbarrows	7,929.56	3,618.90	.4563
Total	15,139.56	6,047.85	

The average cost being $0.39948 per cubic yard.

It is believed that the above methods of loading can be very much improved on and the cost greatly reduced by using mechanical appliances, both for loading stone and spalls on barges from the bank, and also unloading the loaded barges on the upper bank slope at the work.

The most economical method that suggests itself for loading stone from the top of the bank on barges, delivered from cars, that when unloaded covers a considerable stretch along the bank, is the use of small cars and a light track, the loaded car descending by gravity and hauling the empty one up to a turntable on the top of the bank, where the hauling cable is unhitched and the empty car pushed by hand on a side track to be reloaded.

This track can be laid either on an elevated trestle, to allow loading at different stages of water, or over a loading barge. A design for an appliance for loading over a barge has been made for use the present season, which, it is believed, will reduce the cost of loading stone fully 50 per cent and at the same time render necessary a much smaller labor force. Labor is difficult to obtain in sufficient numbers while the main work of revetment is in progress.

For unloading the stone from barges on the slope at the work a device has been designed to be operated by a steam hoisting engine. This consists essentially of a barge upon which is erected a crane and framing for supporting one end of the carrying cable, the other end of which passes over a framed trestle and is anchored to deadmen or other suitable fastenings beyond the top of the bank, the slack of the cable being taken up on the barge. The stone is loaded in a skip and transferred by the crane from the stone barge, which is placed on the

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outside of the barge upon which the apparatus is erected, to a point directly under the cable which carries the skip to the top of the bank. The loaded skip is then hoisted by the hauling line, unlocking the traveling carriage when at a proper height, and the load is drawn up the cable by the hauling line. The carriage, with the skip, after the load is dumped, returns by gravity, the blocks that raise the skip unreaving on account of the slack in the hauling line.

This apparatus will, it is believed, very materially reduce the cost of handling riprap and spalls, and at the same time require a much smaller force of labor. The advantage of this appliance is that it will permit the completion of the bank paving to the full height as the mat work and grading progresses, independent of the stage of water, at a very much reduced cost.

Designs showing in detail both these appliances have been submitted for your approval. The use of a large derrick with a 60-foot boom for unloading stone on the graded slope has also been considered. This may possibly be the best solution for unloading stone, as it is not often that sufficient stone is available at all times to complete the paving of the entire slope as rapidly as the mats are constructed. With the derrick the paving could be laid in strips reaching, say, 10 feet above the stage of the water at the time, and continued up the slope at the higher stages. A first-class derrick will undoubtedly be a good investment, as it would cheapen the work and reduce the labor necessary to a minimum. I would recommend that both the appliances described above be given a fair trial and that a derrick such as described be erected on a barge for unloading stone, feeling satisfied that the investment will be repaid many times over in a few seasons' work, as the labor question is getting more difficult to control each year.

Brush and poles.—A change has been recommended in the specifications for the loading of this class of material. It has been the custom heretofore of loading the brush and pole barges, beginning at one end, to the full height, with the brush laid crosswise, the tops becoming so entangled that it is often very difficult to separate the individual pieces of brush as the barge is unloaded. This renders a larger force of men necessary than if the brush were loaded so as to be readily parted. The change consists in having the brush loaded in layers of 2 feet, extending the full length of the barge, each layer to be separated from the one above by several lines of poles, so as to prevent the tops becoming interlaced and entangled, the poles separating the layers of brush to be used for poling the mat; brush and poles being loaded on the same barge. When a layer of brush has been removed the poles will be placed on the mat and used for poling.

It has been the practice heretofore of having the poles loaded on a separate barge placed on the outside of the mat, and the poles carried and distributed over the mat. This is very hard, disagreeable work, which the laborers will shirk if possible. With the change in loading, as above suggested, the labor of handling poles is reduced to a minimum and considerable labor will be saved in handling brush.

Comparison of methods.—On account of the slow progress made by reason of the scarcity of labor it became evident in November that the work outlined for the season could not be completed with one mat party before the annual rise.

The mat party of the first district having finished the season's work, was transferred to Longwood. This outfit arrived December 4, and constructed and sunk channel mat No. 5. The operations of this party were of great value, both in securing the completion of the season's work and also affording an opportunity of comparing the methods in vogue in the two districts.

The principal departures from the methods in the third district were the use of intermediate barges between the brush barges and the mat barges. These intermediate barges are advantageous in working a large force with a full supply of material, on account of the extra room afforded in which to turn the brush. With a small force on the mat barges the advantage is not so evident, as each piece of brush has to be carried the extra distance of the width of the intermediate barge, 30 feet. With an addition to the width of the platform, making it 12 feet, and the change in the method of loading brush and poles, as recommended above, and employing an ordinary force, the method used in the third district is believed to be the cheaper, as the brush is unloaded directly on the platform of the weaving barge, making a much less distance to carry the material.

The buttress of piles, as used in the first district, for the end of the inside mooring barge to butt against, prevents any inshore movement of the barges, tending to shift the strain on the mooring lines; but as satisfactory results

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are obtained by the use of a heel barge abutting against the bank, the advantage, compared with the cost of procuring and driving piles for the buttress, is not evident over the plan pursued in the third district.

The substitution of ratchets as designed in the first district in place of blocks and falls, is a distinct improvement, not as a labor-saving device, but on account of the fact that the fascines can be bound closer together by its use than by the use of blocks and falls, and with less labor and greater uniformity by the men. It is intended to introduce these ratchets in the present season's work.

The building of mat No. 5 by the party from the first district, under their organization and by their experienced employees, afforded a good opportunity to compare the cost with similar work done by the third district.

Mat No. 1, 964 by 300 feet, containing 2,892 squares, is compared with mat No. 5, 1,016 by 250 feet, containing 2,540 squares. The former built in September, when labor was scarce, an average of 83 laborers being employed; the latter built by the first district force in December, when labor was more plentiful and all conditions favorable, an average number of 156 men being employed. The work done has been reduced to tabulated form for comparison, the basis being 100 square feet of mat constructed ready to sink.

	Time.	Hours per square.	Average force per day.	Material per square.			Cost per square.
				Brush.	Poles.	Stone.	
	Hours.						
Mat No. 1	17,902	6.2	83	1.33	0.05	0.68	$4.26
Mat No. 5	18,708	7.4	156	1.46	.047	.68	4.66

This shows an increased cost of mat No. 5 over No. 1 of 40 cents per square. Making allowance for the 10 per cent increase of brush in fascines, due to the greater number on account of being bound tighter by the ratchets, the labor cost is practically the same for both mats.

Labor.—The supply of labor for the past two or three seasons has not been sufficient for the needs of the work. It is always desirable on account of the short working season to begin the work as soon as the river stage will permit of mat building.

In August, should the river be low enough to begin work, the weather is so hot that negro labor has to be used entirely; and the same may be said of September and the early part of October, at which time cotton picking begins. White labor from the North can not stand the hot and unhealthy season during the months of August and September.

Last season we were short of labor until about the middle of October, when white laborers were brought from Memphis and St. Louis, the Government paying their transportation. By this means a fairly good force was maintained until about the second week in December, when smallpox broke out in the party at Longwood, demoralizing the force. The infected case was isolated and removed to the pesthouse at Greenville. Other cases developed about the 20th of December. These were removed and the quarters disinfected, but it again broke out January 1.

Smallpox broke out in the party at Lake Providence January 28, and it was necessary to pay off the entire labor force on account of the demoralization, which ensued at a time when the repair work needed only a few days to finish. Sufficient local labor could not be procured, and the few days' remaining work had to be deferred on account of ice. This work was finally finished by the force from Longwood.

The above causes, together with the advance in wages over previous season's work, added to the labor cost of the work. It is believed sufficient negro labor can be procured from the eastern part of the State to keep up a full force in September and the first part of October, or until white labor can be obtained by paying transportation, so as not to be dependent entirely on local negro labor, the greater part of whom either have crops of cotton themselves or prefer cotton picking to other work and leave as soon as picking begins.

Maps of Ashbrook Neck, Greenville Harbor, and Lake Providence, showing the locality of the repairs made, and also a map showing the new work at Longwood, have been submitted.

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New work.—The locations where new revetment work will probably be first needed are given in what is considered the order of importance, taking into consideration the interests that would suffer in case the work is deferred.

	Feet.
Left bank, extension of Longwood	1,000
Right bank, upper side of Leland Neck	5,000
Right bank, lower end of Mathews Bend	1,000
Right bank, in front of Reid-Biggs levee	5,000

The new work at Longwood and the repairs to the Lake Providence revetment were under the immediate charge of Mr. George C. Thomas, superintendent.

Following is a statement in detail of these expenditures.

LONGWOOD REVETMENT.

[Season 1904-5.]

Summary of cost.

Classification.	Pay roll.	Subsistence.	Material.	Sundry charges.	Total.
Channel mat	$19,036.88	$6,494.31	$45,656.96	.....	$71,188.15
Pocket mat	2,680.08	897.10	5,627.80	.....	9,154.98
Hydraulic grading	3,291.62	691.91	1,133.89	.....	5,117.42
Dressing grade	1,792.80	611.51	.....	.....	2,404.31
Paving bank	4,816.42	1,642.85	18,200.21	.....	24,659.48
Spreading spalls	1,639.28	559.15	9,616.35	.....	11,814.78
Clearing bank	374.72	127.76	.....	.....	502.48
Drainage	469.78	303.27	152.83	.....	925.88
Towing (steamer Hider)	2,911.33	676.83	2,360.11	.....	5,948.27
Towing (steamer Coppee)	3,994.69	999.32	2,808.68	.....	7,802.69
Supervision	4,129.32	269.47	.....	.....	4,398.79
Outfitting	319.30	48.40	.....	.....	367.70
Property purchased	.....	.....	.....	$4,946.24	4,946.24
Miscellaneous	.....	.....	.....	2,454.63	2,454.63
Engineer office charges	.....	.....	.....	785.71	785.71
Total	45,406.22	13,321.88	85,556.83	8,186.58	152,471.51

Cost per unit statement.

Classification.	Units of work done.	Labor.	Subsistence.	Material.	Total.
Channel mat ..... squares..	12,683.5	$1.5009	$0.5120	$3.5997	$5.6125
Pocket mat ..... do....	1,425.0	1.8457	.6295	3.9493	6.4245
Hydraulic grading ..... linear feet..	4,500.0	.73147	.15375	.25198	1.1372
Dressing grade ..... do....	4,500.0	.3984	.1359	.....	.5343
Paving bank ..... squares..	4,460.0	1.08	.36835	4.08076	5.5291
Spreading spalls ..... do....	2,864.0	.5737	.19523	3.35765	4.12658
Clearing bank ..... acres..	10.6	35.351	12.0528	.....	47.4038
Towing (Hider) ..... days..	86.0	33.8523	7.87	27.443	69.1653
Towing (Coppee) ..... do....	123.0	32.4771	8.1245	22.8348	63.4364

Material expended per linear foot of completed work.

[4,200 linear feet.]

Material.	Quantity.	Units per linear foot.
Brush ..... cords..	20,304.9	4.8345
Poles ..... do....	784.9	.1869
Stone ..... yards..	23,984.17	5.7105
Strand:		
½-inch ..... pounds..	72,103	17.1677
⅜-inch ..... do....	1,820	.4333
⅝-inch ..... do....	26,891	6.4026
¾-inch ..... do....	8,600	2.0476
⅞-inch ..... do....	82,838	19.7233
Galvanized wire, No. 12 ..... do....	29,380	6.9952
Wire, silicon-bronze ..... do....	3,798	.9081
Clips:		
½-inch	4,819	1.1474
⅝-inch	532	.1266
Staples ..... pounds..	3,000	.7147
Spikes ..... do....	170	.04

NOTE.—Material expended on 434 linear feet of mat lost included in the above.

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Material expended per square of channel mat.

[12,683.5 squares.]

Material.	Quantity.	Units per square.
Brush ..... cords..	18,264.2	1.44
Poles ..... do....	634	.05
Stone ..... yards..	8,280.8	.65
Strand:		
½-inch ..... pounds..	72,103	5.685
⅜-inch ..... do....	1,820	.143
¼-inch ..... do....	8,600	.678
7/16-inch ..... do....	24,187	1.907
½-inch ..... do....	74,464	5.871
Galvanized wire, No. 12 ..... do....	26,394	2.081
Wire, silicon-bronze ..... do....	3,793	.299
Staples ..... do....	2,701	.213
Spikes ..... do....	170	.013
Clips:		
⅜-inch	4,819	.38
½-inch	532	.04

NOTE.—Material expended on 434 linear feet of mat lost included in the above.

Material expended per square of pocket mat.

[1,425 squares.]

Material.	Quantity.	Units per square.
Brush ..... cords..	2,040.7	1.43
Poles ..... do....	150.9	.106
Stone ..... yards..	1,338.4	.94
Strand:		
¼-inch ..... pounds..	2,704	1.897
½-inch ..... do....	8,374	5.876
Galvanized wire, No. 12 ..... do....	2,986	2.095
Staples ..... do....	299	.209

Material expended per square of spalls spread (2,864 squares): Spalls, 4,996.51 yards (1.745 yards per square).

Material expended per square of bank paved (4,460 squares): Stone, 9,418.46 yards (2.112 yards per square).

Percentage of cost of the various items of work.

Classification.	Amount.	Percentage.
Superintendence	$4,398.79	2.88490
Channel mat	71,188.15	46.68947
Pocket mat	9,154.98	6.00378
Grading bank	7,521.73	4.77178
Paving bank	36,474.26	23.92135
Clearing bank	502.48	.32955
Drainage	925.88	.60909
Towing	13,750.96	9.18635
Miscellaneous and outfitting	2,822.33	1.84442
Engineer office charges	785.71	.51532
Property purchased	4,946.24	3.24404
Total	152,471.51	100

Percentage of cost of the various expenditures.

Classification.	Amount.	Percentage.
Pay roll	$45,406.22	29.78018
Subsistence	13,321.88	8.73727
Material	85,556.83	56.11332
Miscellaneous	2,454.63	1.60982
Property purchased	4,946.24	3.24410
Engineer office charges	785.71	.51531
Total	152,471.51	100

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Cost per linear foot of completed work.

[4,200 linear feet.]

Classification.	Amount.	Per linear foot.
Pay roll	$45,406.22	$10.8120
Subsistence	13,321.88	3.1729
Material	85,556.83	20.3707
Miscellaneous	2,454.63	.5849
Property purchased	4,946.24	1.1824
Engineer office charges	785.71	.1871
Total	152,471.51	36.31

NOTE.—434 linear feet mat lost included in above statement.

LAKE PROVIDENCE REACH.

[Season 1904-5.]

Summary of cost.

Classification.	Pay roll.	Subsistence.	Material.	Sundry charges.	Total.
Pocket mat	$4,254.98	$1,287.38	$8,596.07	.....	$14,138.43
Paving bank	1,340.11	405.50	3,678.76	.....	5,424.47
Spreading spalls	217.92	65.94	642.29	.....	926.15
Hydraulic grading (grader No. 1)	269.69	58.30	94.60	.....	422.59
Hydraulic grading (pile driver)	317.50	70.59	93.45	.....	481.54
Hand grading	213.20	64.51	.....	.....	277.71
Dressing slope	274.04	82.91	.....	.....	356.95
Drainage	265.86	80.45	.....	.....	346.31
Towing (steamer Hider) double crew	2,801.28	632.31	2,302.45	.....	5,736.04
Towing (steamer Coppee) single crew	270.97	62.16	215.50	.....	548.63
Towing (steamer Titan)	.....	30.67	380.60	.....	411.27
Supervision	937.01	84.45	.....	.....	1,021.44
Miscellaneous	.....	.....	.....	$360.95	360.95
Outfitting	.....	.....	.....	913.28	913.28
Engineer office charges	.....	.....	.....	290.25	290.25
Total	11,162.66	2,925.15	16,008.72	1,564.48	31,656.01

Cost per unit statement.

Classification.	Work done.	Pay roll.	Subsistence.	Material.	Total.
Pocket mat ..... squares	2,256.8	$1.8854	$0.5702	$3.8049	$6.2605
Paving bank ..... do	825.0	1.6245	.4915	4.4590	6.575
Spreading spalls ..... do	183.0	1.6385	.4963	4.8292	6.963
Hydraulic grading (grader No. 1), linear feet	652.0	.41348	.08943	.14519	.6481
Hydraulic grading (pile driver), linear feet	500.0	.635	.1412	.18690	.9631
Hand grading ..... linear feet	180.0	1.18444	.35838	.....	1.5438
Dressing grade ..... do	1,152.0	.23780	.0711	.....	.3089
Drainage ..... do	1,152.0	.23164	.07	.....	.3016
Towing (Hider) double crew ..... days	62.0	45.182	10.1985	37.1363	92.5168
Towing (Coppee) single crew ..... do	9.0	30.108	6.907	23.944	60.959

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Percentage of cost of the various items of work.

Classification.	Amount.	Percentage.
Pocket mat	$14,138.43	44.66
Paving bank	5,424.47	17.13
Spreading spalls	926.15	2.92
Hydraulic grading (grader No. 1)	422.59	1.33
Hydraulic grading (pile driver)	481.54	1.52
Hand grading	277.71	.88
Dressing slope	356.95	1.12
Drainage	346.31	1.09
Towing Hider (double crew)	5,736.04	18.12
Towing Coppee (single crew)	548.63	1.73
Towing Titan	411.27	1.30
Supervision	1,021.44	3.26
Miscellaneous	360.95	1.14
Outfitting	913.28	2.88
Engineer office charges	290.25	.92
	31,656.01	100.00

Percentage of cost of the various expenditures.

Classification.	Amount.	Percentage.
Pay roll	$11,162.66	35.26
Subsistence	2,925.15	9.24
Material	16,003.72	50 55
Miscellaneous	1,564.48	4.95
	31,656.01	100.00

Material expended per square of pocket mat.

[2,256.8 squares.]

Material.	Quantity.	Units per square.
Brush ..... cords..	3,517.9	1.56
Poles ..... do....	138.7	.061
Stone ..... yards..	1,625.	.72
Strand:		
½ inch ..... pounds..	8,000.	3.545
⅜ inch ..... do....	6.200.	2.75
¼ inch ..... do....	1,250.	.554
¼ inch ..... do....	13,500.	5.982
Galvanized wire, No. 12 ..... do....	5,000.	2.24
Staples ..... do....	500.	.224
Spikes ..... do....	30.	.013
Clips, ⅜ inch	754.	.334

Material expended per square of spalls spread (133 squares): Spalls, 324.4 yards (2.44 yards per square).

Material expended per square of bank paved (825 squares): Stone, 1,837.45 yards (2.227 yards per square).

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COST OF REPAIRS TO PLANT.

Third district, improving Mississippi River, May 1, 1904, to May 1, 1905.

Designation.	Cost.	Work done.
Tug Parker	$6,678.22	New hull built; cabin repaired and painted; new furnace, side and back walls; new steam pipe, and general repairs to machinery during the year.
Steamer Arthur Hider	1,335.32	Painting and ordinary repairs during the year.
Steamer H. St. L. Coppee	684.80	Ordinary repairs during the year.
Quarter boat No. 17	16.85	Minor repairs.
Quarter boat No. 19	40.66	Sides and rakes calked.
Quarter boat No. 86	2.90	Minor repairs.
Quarter boat No. 87	19.68	Rakes calked.
Quarter boat No. 88	44.97	Lower seams calked and minor repairs to cabin.
Quarter boat No. 155	51.67	Calked and roof repaired.
Quarter boat No. 156	46.07	Bunks repaired and rakes calked.
Quarter boat No. 157	40.80	Calked.
Quarter boat No. 158	56.14	Do.
Quarter boat No. 159	10.88	Do.
Store boat No. 138	7.38	Minor repairs.
Mat boat No. 28	168.98	New skids and outriggers; breaks and rail clamps repaired and lower seams calked.
Mat boat No. 29	157.86	Do.
Machine shop	68.68	Rakes calked and roof patched.
Carpenter shop	14.36	Rakes calked.
Square barge No. 83	389.80	Docked; 15 new bottom plank; 6 stems in rakes; repairs to bulkheads, and bottom and sides calked.
Square barge No. 111	36.86	Minor repairs.
Square barge No. 204	47.69	Calked.
Square barge No. 210	8.09	Minor repairs.
Square barge No. 217	65.81	Calked and minor repairs.
Square barge No. 224	48.68	Do.
Square barge No. 225	11.20	Minor repairs.
Square barge No. 226	58.75	Calked and minor repairs.
Square barge No. 553	69.94	Deck and sides sheathed, rakes and sides calked.
Square barge No. 556	22.53	Calked.
Square barge No. 560	10.15	Top seams calked.
Square barge No. 562	4.04	Minor repairs.
Square barge No. 566	5.35	Do.
Square barge No. 567	36.59	Calked.
Square barge No. 568	3.25	Battens in hold.
Square barge No. 569	10.00	Calked.
Square barge No. 570	8.57	Do.
Square barge No. 571	10.00	Do.
Square barge No. 573	9.30	Do.
Square barge No. 574	10.00	Do.
Square barge No. 575	14.10	Do.
Square barge No. 576	10.00	Do.
Square barge No. 577	6.83	Do.
Square barge No. 579	10.00	Do.
Square barge No. 580	10.00	Do.
Square barge No. 581	46.78	Do.
Square barge No. 582	8.58	Do.
Square barge No. 584	10.00	Do.
Square barge No. 585	10.00	Do.
Square barge No. 586	10.00	Do.
Square barge No. 588	11.59	Do.
Grader No. 1	3,263.44	General repairs to machinery; docked; new nosing; plank shear; new rake plank; roof repaired; calked.
Grader No. 77	102.35	Machinery overhauled; sides and rakes sheathed.
Pile driver No. 49	19.68	Leads reinforced.
Dry dock	20.74	Minor repairs.
Calking flats	1.80	Do.
Pumps	205.63	Repairs during season.
Levees	11.06	Stakes.
Surveys	86.01	Stakes and target signals; repairs to rudder of steamer Graham.
Construction work	913.28	Pike poles; capstan bars; cable clamps; wire twisters, etc., made; stone carts repaired, and repairs to tools.
General repairs	1,322.77	Overhauling old machinery, and general repairs to property; getting steamboats ready for service during the year, and care of machinery.
Wages of cooks, etc	722.91	Salary and subsistence of cooks, waiters, and supervision necessary to above work.
Total expended	17,129.37	

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The estimated cost of repairs for the ensuing year is given below:

Docking, scraping, and painting the hull of the towboat *Arthur Hiaer*, and repairs	$3,200.00
Ordinary repairs to towboat *H. St. L. Coppee* during year	950.00
Ordinary repairs to tug *Parker* during year	600.00
Repairs to 12 quarter boats, *Nos. 17, 19, 31, 86, 87, 88, 135, 155, 156, 157, 158, 159*	4,000.00
Repairs to 2 mat boats, *Nos. 28* and *29*	900.00
Repairs to carpenter shop, No. 78 (new roof)	220.00
Repairs to machine shop, No. 222 (new roof)	240.00
Repairs to barge *No. 85* (sunk)	500.00
Repairs to barge *No. 111*	20.00
Repairs to 4 third-class barges, *Nos. 204, 216, 217, 561*	280.00
Fitting up barge and appliance for loading stone, including 4 cars	1,350.00
Fitting up barge and appliance for unloading stone	1,500.00
Derrick for unloading stone	1,800.00
Fitting up 2 barges, *Nos. 556* and *568*, for intermediate or fascine barges	1,300.00
Repairing 7 second-class material barges, *Nos. 556, 561, 563, 564, 565, 566*, and *567*	3,062.50
Repairs to hydraulic grader and installation of auxiliary pump	2,500.00
Repairs to pile driver *No. 49*	670.00
Repairs to dry dock (sheathing sides)	975.00
Repairs to 12 first-class material barges, *Nos. 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588*, and *589*	1,350.00
Repairs to skiffs and calking flats	50.00
Total estimated cost of repairs	25,467.50

The new steel towboat *H. St. L. Coppee* was delivered at Greenville, Miss., by the contractor, Ed. I[illegible], July 31, 1904. On a careful examination a serious defect was found in the top of the after end of the starboard cylinder. A new cylinder was promptly furnished by the contractor, and several minor defects that developed in the thirty days in which the boat was on trial were all remedied and the boat accepted. The boat has proved quite satisfactory.

The district now has 2 first-class steel towboats, sufficient for all ordinary revetment work. What is badly needed is a boat of smaller size for surveys and inspection service, as there is none of this class belonging to this district. For such a boat the dimensions should be about 100 by 20 feet, with 3½-foot hold, two boilers, cylinders 12 inches in diameter, engines 6-foot stroke. A stern-wheel boat of this size could be used for towing as well as for surveys and inspections, as it would have sufficient power for that purpose, and be of light enough draft for survey purposes. A steel boat of the above size has been designed, the estimated cost of which is $25,000.

Very respectfully,

ARTHUR HIDER,
United States Assistant Engineer.

Capt. G. M. HOFFMAN,
Corps of Engineers.

APPENDIX 3 B.

REPORT OF MR. LUTHER Y. KERR, JUNIOR ENGINEER, ON SURVEYS IN THIRD DISTRICT DURING SEASON 1904–5.

VICKSBURG, MISS., *May 1, 1905.*

CAPTAIN: I have the honor to make the following report of surveys made under my charge in the third district, Mississippi River improvement, from May 1, 1904, to May 1, 1905:

During the low-water season the following surveys and examinations were made:

The annual hydrographic surveys over the revetment at Lake Bolivar front (417 L.), Ashbrook Neck (446 L.), Greenville Harbor (478 L.), Louisiana Bend (522 R.), Lake Providence (540 R.), and Delta Point (598 R.).

Special hydrographic surveys at Lake Bolivar front, Chicot front (428–432 L.), upper side Leland Neck (469–472 R.), La Grange crevasse (482–485 R.), Kentucky Bend (498–502), Mathews Bend (507–510), Leota Bend (512–514), Lake Providence (540–541), Holly Brook crevasse (545–549), and Delta reach (595–599).

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Shore-line surveys along the upper side of Caulks Neck (408–411 R.), Carters Neck (460–463 L.), Leland Neck (469–472 R.), and Reed-Bedford Bend (603–606 R.).

For a detailed description of the methods of making these surveys, see report Chief of Engineers, 1904, page 241.

ANNUAL HYDROGRAPHIC SURVEYS.

Lake Bolivar front revetment (417 L.).—For several years the outer part of this work has been covered with a heavy deposit, and was protected more or less by a middle bar along the front.

The sections of the October survey show a very heavy scour over the entire revetment, increasing toward the lower end, where a slough occurred, extending from range 1 + 58 to 6 + 28. (See map No. 2.)

The reach survey, extending from the head of Island 76 to the lower end of the revetment, made in connection with above survey, shows that the middle bar has entirely disappeared and that the main channel lies against the lower half of the revetment.

Ashbrook Neck revetment (446 L.).—The sections over this work seem to indicate that the work is in very good condition, except on ranges 12 and 14, where some small sloughs occurred, and at the extreme lower end of the work. There were also two or three small breaks in the upper slope in the vicinity of range 112. The sections do not show a cause for this. The zero line of the bar has receded throughout the upper half and advanced throughout the lower half of the work. Very slight changes in shore line either above or below the revetment. (See map No. 3.)

Greenville Harbor revetment (478 L.).—The section over the Greenville Harbor revetment shows considerable scour on the shore end of ranges 28 to 30 and 33 to 35 and a very heavy fill on range 76.

A break in the upper slope occurred at range 30, also a very small one at the foot of Main street. The latter, however, was below the limit of the harbor survey. No material change in the shore line above the work. The zero line of the bar had moved out slightly on ranges 101 to 125 and from range 8 to 40. The remaining portions are about in the same position as last year. (See map No. 4.)

Louisiana Bend revetment (512–514 R.).—The survey at this point compared with the survey of 1902, none having been made in 1903, shows that the lower end of the Ashton bar, the zero line of which extended down as far as range 110 in 1902, has been cut away, and that deep water strikes in on the main shore at range 100. The maximum caving has been about 200 feet along the lower end of the reach. (See map No. 6.)

Lake Providence revetment (517 R.).—The upper 4,000 feet of this work is now secure from low-water caving, due to the extension downstream of the Longwood bar. Three breaks occurred during the last low-water season; one about range 66, another extending from range 34 to 39, and the other about range 22. The sections over the two upper breaks do not indicate that the channel mat has been destroyed. At the lower end the scour had been very heavy, the slope had become very steep, and it is probable that the slip was superinduced by seep water from the borrow pits along the levee. The zero line of the bar has moved back from 200 to 500 feet. (See map No. 7.)

Delta Point revetment (598 R.).—These sections have deepened considerably from range 4 to 12 east, and have deepened slightly from 12 to "A," the lower end of the work; very little change on the upper end.

There has been some sloughing of the unprotected upper bank from 23 to the upper, 46 + 27, and a slight filling of the upper sections. (See map No. 8.)

SPECIAL HYDROGRAPHIC SURVEYS.

Chicot front (428–432 R.).—About 4 miles of shore line was located along this front. Cross-river ranges were established and sounded and a 10-foot contour map was made of the reach.

Caving continues more or less throughout the reach, the maximum being about 150 feet during the past year, leaving a minimum of about 150 feet of shore in front of the levee. There is a stretch of about 1,200 feet of levee along this front which may have to be covered with a loop.

Upper Leland (469–472 R.).—A survey was made of the upper side of Leland Neck from Columbia to a point about 3 miles below. Four cross-river ranges were sounded to determine contours. The maximum caving in this reach during the year was about 200 feet. There is still a distance of about 1,200 feet between the shore and the axial spur levee and about 1,000 feet to the nearest point of the washout.

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Kentucky Bend (*498–502*).—The conditions of this bend, as shown by the contours, have not improved since the 1903 survey. Caving has been heavy from the head of the bend, 1 mile below Glenora, to Stella Landing. The maximum caving, about 350 feet, was in front of Stella, where the levee is now 550 feet from shore.

A base line 5,500 feet in length was laid out along the shore in front of the Longwood levee, ranges were established every 200 feet, on which the section was determined from the base line to deep water, and 4,500 feet of this stretch, beginning at the upper end, was subsequently covered with revetment. (See maps Nos. 5 and 10.)

Mathews Bend (*507–510*).—Apparently there has been a caving of 250 feet in the lower part of this bend, leaving a minimum distance of 450 feet between the shore and levee at station 3732. I am inclined to question this, however, as the former location of the shore seems somewhat doubtful, and the contours show the deep water to be well out from shore at that point. Six cross-river ranges were sounded.

Leota Bend (*512–514*).—The greatest caving in this bend was 500 feet in three years, in front of the angle at station 2110, where the levee is still 1,200 feet from shore. Six cross-river ranges were sounded.

Survey of a part of Lake Providence reach (*540–541*).—This survey was first made in 1901 in order to determine the effect of dredging through the point of Stack Island bar, that was making over toward the head of the Lake Providence revetment and causing a very destructive pressure at that point. The splendid effect of the work with reference to the upper end of the revetment can be seen by referring to map No. 11.

Delta reach from Youngs Point to Kleinston (*593–599*).—This was the second of a series of surveys which was begun in order to detect any inclination to general caving in the bend above the Delta Point revetment, as it is believed that if this stretch is allowed to become a caving bend the current would be thrown across at the lower end and endanger some of the works put in in connection with the Yazoo diversion canal. The shore lines were relocated, and the 13 cross-river ranges re-sounded. No changes of any consequence had taken place except at the lower end where the 100 contour had moved about 300 feet nearer the lower end of the West Pass levee. (See map No. 13).

Reed-Bedford Bend (*603–606*).—The caving has been general throughout this bend, the heaviest during the past year being 400 feet in front of the levee loop that had just been completed, stations 4459–4549.

Lagrange (*482–485*) *and Hollybrook* (*545–549*).—Resurveys were made at these places to determine the changes in the low-water bed of the river, probably due to the closure of the crevasses. Comparative tables are given herewith showing the changes in the section. The sections at Lagrange show a decrease in area and depth, while those at Hollybrook show a general increase in both respects. (For physical features connected with these surveys see maps Nos. 9 and 10.)

Caulks and Carters necks (*408–411 R.*) *and* (*460–463 L.*).—The caving on the upper side of these reaches has been very light. The maximum for the former being 300 feet in the past year and for the latter 250 feet in two years.

Stack Island Chute.—About 2 miles of shore line along the Mississippi side of Stack Island Chute was located. Some caving has occurred there, but it is so slight that it is hard to assign to it a definite quantity. The levee is within 150 feet of the bank now, but the maps of twenty years ago show about the same conditions.

In addition to the above, preliminary surveys were made for the purpose of making estimates for spur levees extending from the main levee well out to the front on Huntington Point, Ashbrook Neck, Point Comfort, Carters Neck, and Leland Neck, aggregating about 23 miles of transit line, over which elevations were taken every 100 feet.

All the above surveys have been plotted, and the following maps are furnished herewith for your annual report:

Maps Nos. 2 to 8, inclusive, showing the effective revetment at Lake Bolivar front, Ashbrook Neck, Greenville Harbor, Kentucky Bend, Louisiana Bend, Lake Providence, and Delta Point.

Map No. 9. Lagrange crevasse.

Map No. 10. Kentucky Bend.

Map No. 11. A part of Lake Providence reach.

Map No. 12. Hollybrook crevasse.

Map No. 13. Delta reach.

Field operations were begun August 25, 1904, and completed November 17, 1904.

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Expenditures.

Pay rolls	$3,447.04
Subsistence	757.38
Coal	602.13
Miscellaneous charges, including engineer office expense	194.37
Total	5,000.92

Comparative sections, Lake Providence reach.

HOLLYBROOK CREVASSE.

Range.	Area. 1903.	Area. 1904.	Scour.	Fill.	Change in channel depth.
	Sq. feet.	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*
1	31,036	50,759	19,723	.....	+27
2	32,268	41,593	9,325	.....	+ 9
3	27,796	53,786	25,590	.....	- 9
4	26,138	47,238	21,100	.....	+ 1
5	37,114	36,437	.....	680	+24
6	39,721	45,600	5,879	.....	+ 9
7	48,826	70,706	21,880	.....	+34
8	50,680	76,780	26,100	.....	+ 7
[Chute sections.]					
9	5,200	670	.....	4,530	- 7
10	4,478	478	.....	4,000	- 8

Comparative sections, Greenville reach.

LAGRANGE CREVASSE.

Range.	Area. 1903.	Area. 1904.	Scour.	Fill.	Change in channel depth.
	Sq. feet.	*Sq. feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*
1	76,100	50,420	.....	25,680	-13
2	64,510	53,920	.....	10,590	- 13
3	65,900	51,990	.....	13,910	0
4	65,490	51,390	.....	14,100	- 5
5	62,760	51,350	.....	11,410	- 8
6	65,200	56,980	.....	9,220	- 5
7	67,880	59,490	.....	8,390	- 6
8	61,780	48,390	.....	13,390	- 5
[Chute sections.]					
4	2,870	660	.....	2,210	- 2
5	5,000	2,710	.....	2,290	- 3

Respectfully submitted.

LUTHER Y. KERR,
Junior Engineer.

Capt. G. M. HOFFMAN,
Corps of Engineers.

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APPENDIX 3 C.

REPORT OF MR. E. C. TOOLINGER, ASSISTANT ENGINEER, ON OPERATIONS IN LOWER YAZOO LEVEE DISTRICT DURING THE SEASON OF 1904–5.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., May 1, 1905.

CAPTAIN: I have the honor to submit the following report of operations in the Lower Yazoo levee district from May 1, 1904, to May 1, 1905:

Extent of district and yardage.—The district covers the east bank of the river from the Coahoma-Bolivar County line (367 L.) to the mouth of the Yazoo River, which is now at the mouth of the Yazoo diversion canal (599 L.), a river frontage of 232 miles. The line is constructed to a point in Warren County, on Eagle Lake, about 7 miles back of Brunswick Landing (580 L.), leaving about 19 miles of river front unleveed. There is, besides, a levee 8,800 feet long at the extreme lower end of the district, which was built as a part of the Yazoo diversion canal improvement. It is not a part of the levee system, and does not have the same object in view. Parts of Warren, Issaquena, Sharkey, and Yazoo counties are overflowed by the water passing over the unprotected front whenever the gauge at Vicksburg registers more than 45 feet.

The following table shows the length added to the levees by the completion of the new loops and the cubic yards in the abandoned levees:

Location of new loops.	Miles below Cairo.	Beginning of new levee.	Stations.		Length.		Cubic yards thrown out.
			End of new levee.	End of levee, old notation.	New levee.	Old levee.	
					Feet.	*Feet.*	
Australia	370	0	502+49	= 450	50,249	45,000	1,707,400
Jenkins	434	3160	3240+95	=3233+50	8,096	7,350	324,200
Valewood	528	2440	2644+51	=2617+24	20,451	17,724	537,000
Baleshed	535	3135	3224+84	=3238+18	8,984	10,318	249,600
Shiloh	555	4198	4281+45	=4258+70	8,345	6,070	178,800
Total					96,124	86,462	2,997,000

giving a net increase in length of 9,662 feet, or 1.8 miles. Previous length of line, 186.8 miles; present length of levee, 188.6 miles.

	Cubic yards.	
Contents of the levee May 1, 1904		35,615,386
Added during the year by the United States	1,040,708	
Added during the year by the levee board	4,246,661	
Total added during the year	5,287,369	
Abandoned during the year	2,997,000	
Net increase		2,290,369
Contents of levee May 1, 1905		37,905,755

CONSTRUCTION.

1903–4 contracts.—The following table shows all work under contract and not completed at the time of the last annual report:

Station.	Miles below Cairo.	Nature of work.	In place May 1, 1904.	To be placed May 1, 1904.	Contractor.
			Cu. yards.	*Cu. yards.*	
1840–2070	402	Enlargement	67,892	66,148	Lowrance Bros.
2130–2230	403	.....do	35,878	33,773	Do.
3189–3229	434	New work	139,637	11,587	M. J. Roach & Co.
3229–3245	434	.....do	127,418	13,354	Do.
100–200	480	Enlargement	19,930	10,488	Walker Stansell.
1346–1730	500	Banquette	64,695	[a]35,300	Do.

[a] Contract abandoned June, 1904.

All of these have been completed during the present year.

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1904–5 contracts.—The following work was let April 13, 1904, to be paid from allotment of $150,000, made from appropriation for the fiscal year 1905:

Station.	Miles below Cairo.	Nature of work.	Price.	Contractor.
			Cents.	
32–100	478	Enlargement	18.9	M. J. Roach & Co.
200–520	483	Topping	18.9	Do.
520–600	483	Enlargement	18.9	Do.
940–1200	495	.....do	18.9	Do.
1200–1370	497	Topping	18.9	Do.

This was all to a grade 2 feet above the 1903 high water.

A table giving the sections into which this work was divided, and the yardage and details of cost, is appended to this report.

The enlargement was on the river side, except stations 990–1030 and 1037–1055, which was placed on the land side on account of the levee being too close to Lake Lee for the material to be obtained from the river side.

The enlargement on the river side had a crown 8 feet wide and slopes 3 to 1. The enlargement on the land side had crown 8 feet wide and 3 to 1 slopes to banquette, which was raised to make it 8 feet below the top of the new crown, and gave a crown 20 feet wide and 10 to 1 and 4 to 1 slopes. The topping on stations 205–520 and 1200–1207 had a crown 4 feet wide and slope 3 to 1 on land side and 2 to 1 on river side, the foot of the land side slope being on the edge of the old crown. The topping on stations 1207–1370 had a crown 2 feet wide and arbitrary slopes, the base having the same width as the old crown of the levee. This change was made after the rains had made it impossible to complete the heavier topping and while it was possible for a high water to follow later.

Besides the regular contracts for 1904–5, an informal contract was made with George Stephany for the construction of a subbanquette at station 1930 above Greenville. This contract was for 1,594 cubic yards, at 18 cents per cubic yard, amounting to $286.92. All uncompleted contracts for 1903–4 and all contracts for 1904–5 have been completed during the year.

1905–6 contracts.—The Fifty-eighth Congress having passed an act to enable the work which is to be paid from the appropriation for the fiscal year 1906 to be done in the year 1904–5, the following work was let July 28, 1904, from the allotment of $150,000 from that appropriation:

Station.	Miles below Cairo.	Kind of work.	Price.	Contractor.
			Cents.	
4894–5020	569	New loop	16.3	Lewis & Jennings.
5200–5588	573	Enlargement	16.3	Do.

The division of the above into sections, and the details of yardage, cost, and force, are given in a table appended to this report.

The appropriation for the contractors not being available until July 1, 1905, the Mississippi levee board arranged for the payment of the interest on the monthly estimates from the time they became due until the above date. This was done in order to get the work done before the possible advent of a flood in March or April, 1905.

The standard section for the new loop is, crown 8 feet wide, slopes 3 to 1, and no banquette.

The standard section for the enlargement is, crown 6 feet wide, and slopes 3 to 1 on land side, and 2½ to 1 on river side, except about 15,000 feet, which has a 2 to 1 slope on the river side. This is the smallest levee in the district, having an average height of about 6 feet.

The necessity for the new loop arose from the caving bank opposite, and the necessity for it being included in this project arose from the danger of the old levee being breached before the end of the year 1904–5. Rains and seep water retarded this work so much that on May 1, 1905, only 90 per cent was in place.

The enlargement on stations 5200–5588 was commenced October 10, 1904, but no work was done on it from December 24, 1904, to February 2, 1905.

This work was so situated that it would drain readily, and the water in the river and the lake did not get high enough to interfere very much with it; nevertheless

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only 36 per cent of the work had been done to March 1, and 86 per cent to May 1, 1905.

In the construction of the new loop, stations 4894–5020, wheel scrapers and grading machines and wagons were used, the team force being used to propel the machines and wagons being used in hauling the material into the levee. On all of the other contracts wheel scrapers alone were used.

A comparison of totals of yardage and force on the contracts, with and without grading machines, shows a difference of 5 per cent in yardage per team day against the use of machines and 15 per cent in yardage per man day in favor of their use.

The average price of work let during the year was 17.3 cents per cubic yard.

Construction by the Mississippi levee board.—The Mississippi levee board (Lower Yazoo district) has done an extraordinary amount of levee building this past year. They were enabled to do this by the sale of $1,000,000 worth of bonds, specially authorized by the State legislature during the session of 1903–4, in addition to the annual revenues.

A tabulated statement of the work done by this levee board is appended hereto. It will be noted that 97 per cent of the expenditures during the year were for new loops, and all of these are behind levees menaced by caving banks.

REPAIRS AND MAINTENANCE.

The Government employed a force of 5 teams above and 10 teams below Greenville from June until September, and a force of 10 teams below Greenville during October and November, and above Greenville in December, under Government supervision, but paid for by the Mississippi levee board, from an appropriation of $5,000 for repair work.

As it was evident that the weed cutting could not be done in proper time by these forces doing it in connection with the other work, the weeds were cut by contract over 72 miles of levee.

Besides the repairs by the above forces, the contractors for the levee enlargement and topping cut the weeds and removed the drift from both sides of that part of the levee included in their contracts. This was in accordance with the terms of their contracts and therefore added nothing to the expenditures for repairs.

The total repairs by the United States amounted to $8,191.21; the total repairs by the levee board amounted to $4,751.30.

Below is a tabulated statement of work done by day force:

Station.	Miles below Cairo.	Kind of work.	Number of stations.	Cubic yards.	Cost per yard or station.	Amount.
Above Greenville:						
1124–1226	392	Weed cutting	243		Cents. 50	$121.50
1325–1476	395					
1383–1390	396					
1400–1460	397					
1148–1141	395	Rain wash		2,140	30	642.00
450–490	373					
595–642	374					
1038–1226	380	Weeds cut and logs removed	598		50	299.00
1325–1648	395					
3330–3345	435	Wave wash		542	30	162.60
2280–2485	407					
2485–3300	415	Weed cutting	1,033		50	516.50
3330–3343	435					
2514	416	Wash repaired				14.40
Total						1,756.00
Below Greenville:						
0–40	480	Weeds cut and drift removed	Linear ft. 16,700			349.04
123–150	481					
150–250	482					
140–208	481	Rain and wave wash		1,810	30	543.00
600–940	492	Weed cutting	3,400			136.00
600–880	492	Drift and logs removed	2,800			554.08
745–850	493	Rain wash		1,050	30	315.00
780–915	493	Wave wash		4,050	35	1,417.50
1800–2275	493	Weeds cut	47,500			1,425.00
Total						4,739.62

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Proposals for weed cutting were opened in July and August, 1904, as follows:

Station.	Contractor.	Number of stations cut.	Price per station.	Cost.
			Cents.	
Above Greenville:				
3300–4200	Sam Rains	900	50	$450.00
Below Greenville:				
1370–1800	James Overall	413	50	206.50
2275–5200	J. M. Chilton	2,607+22	30	752.17
Total				1,408.67

Repairs done under Government supervision paid for by the levee board were as follows:

Station.	Miles below Cairo.	Nature of work.	Linear feet.	Cubic yards.	Amount.	Price per cubic yard.
					Cents.	
Above Greenville:						
1875–2000	401	Rain wash in banquette repaired.		4,550	30	$1.365
Below Greenville:						
880–940	493	Drift removed	6,000			240
850–977	493	Rain wash in banquette repaired.		1,500	27	405
885–895	493	Wave wash repaired		2,900	27	783
915–940	493	....do		5,800	27	1,566
890–940	493	Resodded	5,000			50
2160–2275	515	Weeds cut and drift removed.	11,500			342
Total						4,751

Summary of work done by the repair forces.

	Miles of levee.
By the United States:	
Cut weeds on, and removed drift from	40
Cut second growth of weeds from	2½
Repaired rain and wave wash on	6
Resodded	1½
Resodded rain and wave wash on	7
By the levee board:	
Cut weeds and removed drift from	6½
Repaired rain wash on	2½

HIGH-WATER MAINTENANCE.

The highest water this year culminated at Cairo on March 17, and along the front of this district on March 26, 1905.

The maximum gauge readings for the years 1897 to 1905 are as follows:

Miles below Cairo.	Station.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.
0	Cairo	51.6	49.8	46.2	39.2	43.2	42.2	50.6	49.1	38.4
230	Memphis	37.8	37.6	35.2	29.5	32.1	30.9	40.1	39.2	29.0
306	Helena	51.8	49.1	46.8	38.3	41.5	39.6	51.0	47.6	37.0
353	Sunflower	47.2	46.0	44.3	37.1	40.5	38.8	48.0	44.5	36.1
393	Mouth White River	52.4	51.1	48.5	40.9	44.7	43.3	53.7	49.5	41.2
438	Arkansas City	51.9	51.1	48.6	39.3	43.3	41.4	52.9	49.0	39.8
478	Greenville	46.8	46.2	43.0	33.8	37.4	36.1	49.1	43.6	33.9
542	Lake Providence	44.4	44.4	41.7	33.0	36.5	35.0	46.5	42.5	33.5
599	Vicksburg	52.4	49.4	47.3	38.0	41.5	41.2	51.8	46.9	37.7

It will be seen that the floods for the years 1900 and 1905 were the lowest here recorded and that they attained about the same height, the latter flood being slightly the lower at Cairo and Vicksburg and slightly the higher at Arkansas City.

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The high water of 1905 is shown by the table to have been from 13 to 15 feet below the highest known water, that of 1903. The high water of 1905 was generally within the banks of the river. It was therefore not high enough to reach our high-water gauges along the line of levee, and the maximum stage, therefore, has not been established and recorded for the local points along this front. For a comparison of the high water of 1904 with that of 1897 and 1903, see table page 219, Supplement to Report of Chief of Engineers, 1904.

Surveys, etc.—Surveys have been made in this district as follows:

Surveys of defects of levees of the district in June, 1904.

Surveys of levels on top of the levees of the district, March and April, 1905.

Change in location of Albermarle new loop (569 L.), July, 1904.

Distances from levee to river at Choctaw Bend (437 L.), above Greenville (476 L.), below Greenville (478 L.), Longwood (501 L.), Island 92, Shiloh (555 L.), from time to time throughout the year.

Shore lines by Australia (370 L.), Carters Neck (461 L.), Lagrange (480 L.), Longwood (501 L.), and Leota (514 L.).

Bank lines.—Caving has been quite active at a few points during the year, but generally it has been much less rapid than during the year 1903–4.

Shore line surveys and measurements from levee to river bank to determine the amount of caving were made during the year, showing the results given below.

Parkers to Dennis Landing (367–373 L.).—In February, 1904, a survey of this shore line was made by the Mississippi levee board. A comparison of the present shore line with the one then surveyed shows that, during the past ten months, the caving at station 135 amounted to 360 feet, or within 90 feet of the toe of the levee, and at station 390 it amounted to 300 feet, or within 250 feet of the toe of the levee. After extensive surveys, the new loop to be built on account of this caving was located back of Lake Charles, partly in the Upper and partly in the Lower Yazoo levee district, and each of the two local levee boards built the portion within its bounds. The arrangements between the boards provide for the maintenance of the old levee on the north side of the neck by the Upper Yazoo levee board to prevent a cut-off across that neck, and the consequent damage to levee interests that would result therefrom. (See accompanying table of work by the levee board).

Waxhaw front (392–394 L.).—There was very little caving on this front after the completion of the new levees in 1903–4 until the river reached its recent high stage, when it became more active. It was expected that the high water of 1904 would breach the old levee before the loop was finished, and the construction force was therefore greatly increased; the old levee is, however, still intact, though it will probably be breached in the next considerable high water.

The latest measurements from the bank to the old levee show the following results:

	Feet.
Station 1180:	
February 15, 1904	442
May 1, 1905	400
Station 1253:	
February 15, 1904	635
May 1, 1905	275

Choctaw Bend (430–435 L.).—Caving along this reach has practically stopped, except at the lower end, where it is progressing at a moderate rate. It does not now appear that the new loop (Jenkins, 434 L.), which was commenced during the year 1902–3 and completed in 1904–5, will be needed in the near future. The construction of this levee was pressed by the landowners that would have been thrown out by the proposed line back of Lake Bolivar and was a compromise between building a levee on that line or a revetment of the front.

Bachelors Bend (475–479 L.).—The caving is very light along the lower and only moderate along the upper unprotected parts of this reach. The levee being situated quite a distance from the bank of the river, the caving at its present rate will do little damage except to the land and timber on the front and the protection from wave wash which the timber now affords to the levee.

Below Greenville.—Active caving continued for a short time on this reach. It was evidently caused by the La Grange crevasse, and almost entirely ceased when that was closed. The hydrographic surveys do not indicate that there will be any active caving in this vicinity in the near future.

Longwood Front (499–502 L.).—The caving at this point had been very active until a new revetment was constructed on this front. This was decided upon after elaborate surveys and careful study, it being shown that this would be much cheaper

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than the construction of the new levee that would otherwise be required and would afford better protection to the interests involved. The estimates upon which this decision was based, were as follows:

Estimated cost of embankment.

[Grade 2 feet above high water of 1903, crown 8 feet, slopes 3 to 1. Banquette 8 feet below top of levee, crown 20 feet, back slopes 5 to 1.]

Station.	Average height.	Embankment.	Excavation.	Total.	Price.	Total cost.
	Feet.				*Cents.*	
1270–1438	(a)22.3	512,390	70,000	582,390	22	$128,125.80
1438–1457	(b)24.8	252,339	8,000	260,339	25	65,084.75
1457–1493	(c)29.5	839,196	142,000	981,196	35	343,418.60
1493–1611	(d)21.0	897,895	34,000	931,895	20	186,379.00
Total		2,501,820	254,000	2,755,820		723,008.15

Estimated shrinkages included in above height: (a) 1 foot; (b) 5 feet; (c) 10 feet; (d) 1 foot.

Total cost of levee including right of way.

Embankment per above statement	$723,000
Right of way including improvements	20,000
Actual estimated cost of levee	743,000
Value of property destroyed	50,000
Total	793,000

Estimated cost of revetment.

14,450 linear feet, at $31 per foot	$447,950
Enlarging present levee to 2 feet above 1903 high water, 260,000 cubic yards, at 30 cents per cubic yard	78,000
Total	525,950
Revetment urgently needed, 5,500 linear feet, at $31	170,500

This revetment work was begun in the fall of 1904, and 4,200 feet of it was completed. During the high stages of the river this spring there was considerable caving just below this revetment, and at an angle in the levee about 1 mile below. On account of this the revetment should be extended during the season, and a short loop may be necessary to cover the threateded angle.

Island No. 92.—There has been very little caving at this point during the past year. The nearest point was 480 feet from the levee in April, 1904, and there has been but little caving for several months past.

The rapid increase in the rate of caving during the high water of 1903 was taken as evidence that caving would reach the levee at an early date, and the levee board contracted for a new loop on this front on this account. (See tabulated statement of the levee board work, appended to this report.)

Fillers (551 L.).—Caving has been very active. A survey of the shore line in March, 1905, showed a change of 950 feet since May, 1902, or about 335 feet per year. As it was then within 350 feet of the center of the levee, and the season of its greatest caving not yet over, the necessity for the early construction of a new loop on this front seems quite apparent. The Mississippi levee board is fully impressed with the urgency of this work, and will assume the construction of it if later conditions prove to be as grave as is now anticipated.

Shiloh Front (555 L.).—The caving was very rapid along this reach during the high water of 1903, reaching within 450 feet of the levee. During the high water of 1904 it came within 400 feet of the levee. The levee board constructed a new loop on this front during the present year on account of these conditions. (See table of work done by the levee board, appended to this report.)

Duvalls to Chotards (568–570 L.).—Caving continues throughout this reach. The shore line survey of April, 1904, showed that the caving opposite station 4903 had amounted to 280 feet in eight months, and was within 480 feet of the levee. It is now within 300 feet of the levee, having caved 180 feet in twelve months. A new levee is being constructed on this front by the United States, from allotment under

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first appropriation for fiscal year 1906. The indications are that the front levee will be breached by the time the new back line is completed. (See tabulated statement appended to this report.)

General remarks in regard to caving.—The importance of the subject warrants very extensive surveys and a careful study of the results and the principles involved. At present predictions in regard to caving can only be made for the immediate future and then with a very wide margin. The subject lies at the very foundation of river control, and its study is important, not only for the sake of knowing where, when, and how rapidly caving is liable to occur, but for the sake of knowing how it may be controlled, and how and when to apply each of its several elements of control—dredging the channel, revetting the bank, changing the location of the levee, or the placing of other impediments to the flow of the water, whether in the stream, along the bank, or on the shore. The importance of the matter to levee interests can be easily appreciated after noting the expenditures for new loops during the past year, all built on account of the approach of caving banks.

Some of the new loops, it is true, may not be needed in the near future, but the margin was getting so small, the future caving was so uncertain, and the interest jeopardized so great, that wisdom dictated their construction. If the future caving at any point could be predicted with any certainty, large sums of money could be saved in levee construction by not changing the location until known to be necessary, and then avoiding unnecessary expenditures, either on an expensive levee unnecessarily far from the river or on one less expensive perhaps but that will have to be renewed in a few years on account of the further encroachment of caving. The saving that would be effected by having full and accessible information, obtained from careful surveys made from time to time, would amount to many times the cost of the surveys.

These surveys should be made at least once a year, preferably during low water, and oftener would be better, and since there is such a difference between different caving banks, in the effect that different stages of the river have upon them, measurements to the banks, preferably from the levee, should be made from time to time throughout the year. These surveys should not only include the tracing of the shore line, but also topographic and hydrographic surveys in the vicinity.

Extension at the lower end of the district.—The water begins to flow around the lower end of the district, and overflows that part of the country as soon as the river reaches 45 feet on the Vicksburg gauge. A rise of 3 more feet overflows an area of about 500 or 600 square miles, and stops all traffic on the Yazoo and Mississippi Valley Railroad, affecting not only railroad interests, but those of the community at large. As the maximum stage of the flood of 1903 showed a fall of 7.4 feet from Brunswick (573) to Vicksburg (599), the extension of this levee to join the one at the mouth of the Yazoo diversion canal would prevent nearly all of this great. and almost annual, devastation. Besides, the construction of this extension, which will have to be undertaken at some time, will change the high-water slope, and the consequent grade, of the levee, bringing them more nearly parallel to the ultimate and more uniform grade yet to be established. This extension should not be undertaken, however, until the present levee has been brought to a standard section, for any crevasse in the latter would cause many more times as much damage as is now caused by the overflow around the present end of the levee. But since every extension of the levee will contribute its part to the ultimate results, shorter extensions could be made at different times whenever consistent with the conditions of the already constructed levee and the amount of available funds.

Elaborate surveys should be made in the near future, so that the problems of cost, proper location, and ultimate results can be made from time to time, and that the construction of parts of the extension can be entered upon at the proper time.

SPUR LEVEES OR DIKES.

Besides the above extension of the levee system, there will have to be some lateral extensions in the way of spur levees to be built from the main levee, out on the long points between bends of the river. These would not only be an important element in the prevention of cut-offs, but would also assist in giving more uniformity to the high-water slopes, more regularity to the current, and thereby more stability to the banks.

The question as to the effect their construction would have on gauge relation was brought up by Assistant Engineer A. M. Todd, whose reports and papers have brought out quite a discussion on the subject during the past year. It was generally agreed that the effect would be favorable, but that the extent of the effect could only be definitely settled by the construction of some of these dikes and the study of future floods.

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CONDITION OF THE LEVEE AND ESTIMATE FOR CONTINUED CONSTRUCTION.

Much of the levee in this district was constructed while defective methods of construction obtained. Aside from the relocations caused by caving banks, a very small portion of this levee has been relocated. It has all been enlarged from time to time, and portions have been reinforced by banquettes, but there are still many miles of bad levee to maintain. There are also levees so close to lakes and bayous that material can not be obtained on the river side of them for future enlargement. The levees in this district will not equal the Arkansas levee, so much of which was relocated and built by the United States in 1893–1896, until many miles of it also shall have been rebuilt. This should not be done, however, until all of the levee shall have been brought up to a grade 2 feet above the highest known water, and have a standard section, including banquette.

A profile showing the top of the levee and the high-water slopes is submitted herewith.

The following is an estimate of the height of the levee above the high water of 1903:

Above Greenville.	*Below Greenville.*
6.5 miles, 0.5 to 1 foot above.	61.9 miles, 0 to 1 foot above.
16.2 miles, 1 to 1.5 feet above.	2.4 miles, 1.4 feet above.
7.4 miles, 1.5 to 2 feet above.	26 miles, 2 feet above.
45.2 miles, 2 to 2.5 feet above.	6.7 miles, heavy topping, 2 feet above.
0.7 mile, 2.5 to 3 feet above.	8.3 miles, light topping, 2 feet above.
11.2 miles to Commission grade.	

The yardage required to bring the levee up to a grade 2 feet above the highest known water, with standard section, including the new loops that will be required this year, is as follows:

Above Greenville:	Cu. yards.	Below Greenville:	Cu. yards.
Embankment	513,250	Embankment	2,483,540
Banquette	25,800	Banquette	333,300
Total	539,050	Total	2,816,840

The following is an estimate of the yardage and cost of the more urgent of the above work:

Station.	Miles below Cairo.	Kind of work.	Cubic yards.	Estimated cost. Price.	Estimated cost. Amount.	Remarks.
				Cents.		
Above Greenville:						
1550–1843	398	Enlargement	239,000	20	$47,800	Urgent.
3981–4200	476	.....do	174,000	22	38,280	Necessary.
Total			413,000		86,080	
Below Greenville:						
1200–1475	496	Enlargement	170,000	20	34,000	Urgent.
1600–2440	503	Topping	168,000	30	50,400	Necessary.
2580–3135	529	Enlargement	450,000	22	99,000	Do.
3225–3491	538	Topping	53,200	30	15,960	Do.
3587–4200	548	Enlargement	490,400	20	98,080	Do.
4300–5200	557	Topping	157,000	30	47,100	Do.
Total			1,488,600		344,540	
Longwood:						
1475–1575	502	New loop	632,000	20	126,400	Urgent.
Fitlers:						
3909–3951	551	.....do	250,000	22	55,000	Do.
Total			882,000		181,400	

SUMMARY.

Above Greenville	Embankment	413,000	$86,080
Below Greenville	.....do	1,488,600	344,540
Do	New loops	882,000	181,400
Total		2,783,600	612,020

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COMMISSION GRADE.

The following is an estimate of yardage required to raise and enlarge the levees of this district to standard section and to the ultimate grade adopted by the Mississippi River Commission and known as the Commission grade, which is about 6 feet above the high water of 1897:

		Cubic yards.
Enlargement:		
Embankment	8,935,021	
Stumps, spurs, road crossings, etc	557,000	
Increase for sinking	1,900,000	
		11,392,021
Banquette:		
Embankment	613,317	
Stumps, etc	75,000	
		688,317
Total enlargement and banquette		12,080,338
Add for new loops		1,500,000
Grand total		13,580,338

PRIVATE LEVEE.

A private levee was constructed at the lower end of the present levee system by the planters whose property is protected by it. It is a back levee extending from station 5100 to 5587 + 46 of the United States levee, and in connection with the latter inclosing about 6,000 acres of land, 2,000 of timber and 4,000 cultivated. The following further information in regard to this levee is submitted:

Length of levee line, 3.9 miles; average height of levee, 5.2 feet.

Cost of levee:	
Embankment, 89,708 cubic yards	$12,719.58
Right of way	2,568.10
Engineering, etc	2,178.98
Total	17,466.66

Specifications in general.—Specifications for levee construction have been improved from time to time, so that now very few further changes seem to be needed. I do recommend, however, that the provisions contained therein shall be more uniformly and rigidly interpreted and enforced.

Layers and runways.—The 2-foot layers are never rigidly insisted upon, either in Government or levee board work. This defect is very much increased by having numerous runways, in filling over which the material can neither be placed in layers nor tamped. I would recommend the additional provision that runways be not allowed except at the station ends of the levee, and that these shall be parallel to the axis of the levee. But neither this specification nor one in regard to the thickness of the layers can be enforced at all unless uniformly enforced throughout the district, with the active support of all the levee authorities therein.

Sodding—The acceptance of the levee in lengths of 1,000 feet or more is provided; but with the further provision that the engineer may dictate at what time the sodding may be done. It is very much to the advantage of the contractors to keep the dressing and sodding as far advanced as possible, and this should be insisted upon at all times, except that sodding should not be done during a very dry season or a very cold season if a better season is likely to prevail before the other work in the contract is completed.

Contract time, labor conditions, etc.—On account of the almost invariable prevalence of rain and other unfavorable conditions in January and February, which are often followed by high water in March or April, an early date should be fixed for the completion of all contracts; and I would respectfully recommend that, for construction generally, the time limit be not later than January 31. I would further recommend the strict enforcement of the provision in the contract that a sufficient force be maintained at all times to complete the work on time.

Labor has been so scarce during the past few years that this becomes a question of the amount of labor rather than the number of teams that the contractor can command. In bidding, therefore, he should consider the labor conditions in general and his own ability in particular to obtain sufficient labor.

More bank revetment.—Attention has already been called in this report to the extraordinary amount of levee building during the past year that was necessitated

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by caving banks. Very important banks are now revetted, including those that threaten levees whose reconstruction, together with the damages to property, would be more expensive than the necessary revetment, as at Longwood, already referred to.

If, then, the same results could be obtained much more cheaply by other than the present methods, it follows that much more levee building could be saved in this way. Now, changes in points of deposit and in the direction of the current have had for their initial causes such small affairs as the sinking of boats, trees, etc.; and, this being so, it would seem that a well-directed location of a revetment of a much more temporary character could be made to deflect the current to other points as desired.

EXPENDITURES.

The distribution of the expenditures for the year ending May 1, 1905, is as follows:

Designation.	Amount.	Per cent.
Construction	$181,090.50	89.9
Repairs	7,904.29	4.0
Engineering	12,480.72	6.1
Total	201,475.51	100.0

ACCOMPANYING PAPERS.

The following statements and blueprint accompany this report:

Statement of levee construction by the United States.

Statement of levee construction by the Mississippi levee board.

Statement of rainfall at Greenville, Miss.

Profile showing top of levee, 1905, and high-water slopes of 1897, 1898, 1903, and 1904.

Respectfully submitted.

E. C. TOLLINGER,
United States Assistant Engineer.

Capt. G. M. HOFFMAN,
Corps of Engineers.

Levee work in Lower Yazoo levee district, May 1, 1904, to May 1, 1905.

[E. = Enlargement; B. = Banquette; T. = Topping; N. = New.]

Station.	Miles below Cairo.	Contractor.	Cubic yards in contract.	Cubic yards placed during year.	Total labor days.	Total team days.	Total scraper days.
1840–2070	402	Lowrance Bros	134,040	66,148	2,716	2,119	1,396
2130–2230	403	do	69,651	33,773	1,331	1,020	620
3189–3229	434	M. J. Roach & Co	151,224	[a] 12,646	598	458	286
3229–3245	434	do	140,772	[b] 14,532	959	744	484
32–100	478	do	34,007	34,007	1,632	1,150	720
100–200	480	Walker Stansell	30,418	10,488	427	281	196
200–550	483	M. J. Roach & Co	44,119	44,119	2,444	1,665	1,041
550–600	483	do	25,318	25,318	1,147	807	506
940–1000	494	do	42,350	42,350	2,367	1,724	1,128
1000–1100	495	do	97,402	97,402	5,818	3,954	2,561
1100–1200	496	do	94,011	94,011	4,009	3,071	1,899
1200–1370	497	do	7,590	7,590	560	387	347
1346–1730	500	Walker Stansell	127,872	[c]			
4894–4930	569	Lewis & Jennings	[d] 130,000	98,012	3,840	[e] 4,320	[e] 2,072
4930–4974	569	do	[f] 193,000	176,744	8,252	[e] 8,142	[e] 4,553
4974–5020	569	do	[g] 178,888	178,888	7,033	[e] 6,605	[e] 3,994
5200–5588	573	do	120,000	103,086	4,275	2,785	1,760
1930	402	Geo. Stephany	1,594	1,594			
Total			1,622,256	1,040,708			

[a] 1,059 cubic yards.
[b] 1,178 cubic yards; paid for by Mississippi levee board.
[c] 63,177 cubic yards; paid for by Mississippi levee board. No work. Contract abandoned June, 1904.
[d] 31,988 cubic yards required to complete.
[e] Graders and wagons used. Graders estimated as equal to 7 teams and wagons equal to 2 scrapers.
[f] 16,256 cubic yards required to complete.
[g] 16,914 cubic yards required to complete.

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Levee work in Lower Yazoo levee district, May 1, 1904, to May 1, 1905—Continued.

Station.	Miles below Cairo.	Yards per team.	Yards per scraper.	Price per cubic yard.	Average height.	Average haul.	Kind of work.
				Cents.	*Feet.*	*Feet.*	
1840–2070	402	31	47	18.0	18.7	125	E.
2130–2280	403	33	54	17.9	18.7	150	E.
3189–3229	434	28	44	19.7	15.1	200	N.
3229–3245	434	20	30	19.7	24.1	600	N.
32–100	478	30	47	18.9	17.0	125	E.
100–200	480	37	54	15.74	15.0	125	E.
200–550	483	26	42	18.9	11.8	125	T.
550–600	483	31	50	18.9	12.2	125	E.
940–1000	494	25	38	18.9	19.0	175	E.
1000–1100	495	25	38	18.9	17.8	225	E.
1100–1200	496	31	50	18.9	18.5	150	E.
1200–1370	497	20	31	18.9	16.2	150	T.
1346–1730	500	.....	.....	15.74	11.9	.....	B.
4894–4930	569	23	47	16.3	15.8	225	N.
4930–4974	569	22	39	16.3	17.2	225	N.
4974–5020	569	27	45	16.3	17.0	225	N.
5200–5588	573	37	59	16.3	8.3	100	E.
1930	402	.....	.....	18.0	.....	.....	B.

Table showing levee construction by the Mississippi Levee Board from May 1, 1904, to May 1, 1905.

[E. = Enlargement; B. = Banquette; N. = New; S. = Spur; T. = Topping.]

Station.	Miles below Cairo.	Cubic yards in contract.	Cubic yards placed during year.	Price per cubic yard.	Extras paid.	Total expended.	Kind of work.
				Cents.			
0–502	370	3,047,408	2,889,226	19.7	[a] $17,750.23	$591,602.02	N.
0–502	370	.....	[b] 60,621	.....	.....	.....	
1645	400	10,247	10,247	18.0	276.83	2,121.29	S.
3100–3245	434	76,394	4,314	19.7	.....	[c] 1,376.22	B.
3850–3981	455	90,569	15,286	22.0	.....	5,847.26	E.
850–977	493	14,500	14,500	.....	.....	[d] 4,651.39	T. and E.
1346–1730	500	63,177	.....	15.74	.....	[e] 994.41	B.
2440–2645	528	748,000	745,868	13.4	[f] 1,574.95	86,529.31	N.
2440–2645	528	.....	[f] 11,468	.....	.....	.....	
3135–3225	538	333,461	235,717	14.0	.....	35,053.00	N.
4013–4243	550	98,884	3,576	22.0	.....	3,938.67	B.
4013–4243	550	70,396	4,031	31.0	.....	4,335.58	T. and E.
4198–4281	556	276,000	251,807	13.4	.....	28,680.82	N.
Total	.....	.....	4,246,661	.....	19,602.01	765,129.97	

[a] On account of sinking foundation and repairing rain wash on received work.
[b] For revetting end of spur.
[c] Under Government contract and paid for by Board.
[d] Topping and repairing washes. Done by day work under Government supervision.
[e] Retained percentages on work previously done.
[f] Repairing rain washes on work previously received.

Rainfall at Greenville, Miss., from May 1, 1904, to May 1, 1905.

Month.	1904.	Mean 1886–1905.	Month.	1905.	Mean 1886–1905.
	Inches.	*Inches.*		*Inches.*	*Inches.*
May	1.17	3.48	January	7.31	4.96
June	8.52	3.91	February	4.40	4.26
July	3.41	4.16	March	4.84	5.79
August	1.64	3.39	April	7.73	4.09
September	.02	2.75			
October	.15	1.90	Total	51.38	46.52
November	3.32	3.67			
December	8.87	4.16			

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APPENDIX 3 D.

REPORT OF MR. A. MILLER TODD, ASSISTANT ENGINEER, ON OPERATIONS IN UPPER TENSAS LEVEE DISTRICT DURING THE SEASON OF 1904–5.

VICKSBURG, MISS., *May 1, 1905.*

CAPTAIN: I have the honor to submit the following report of operations in the Upper Tensas levee district, covering the period from May 1, 1904, to May 1, 1905:

Extent of district and yardage.—The levees embraced in this district consist of two separate lines, as follows:

Arkansas River levee: Extends from Redfork, 22 miles above the mouth of the old Arkansas, to station 783, about 5 miles above the mouth; thence an extension from station 783 to 926 is under construction along Dry Bayou, extending toward the Mississippi River levees, which will make a total length for this levee line of 17.5 miles. Above Redfork the levee is maintained by local authorities to the high ground above overflow at Pine Bluff, a distance of 80 miles.

Mississippi River levee: On account of the relatively large drainage basin of Cypress Creek, flowing into the Mississippi (426 R.), it is deemed impracticable to levee across this stream. Hence the Mississippi River levee begins at present at Costello's gin, on the bank of Amos Bayou, a point above overflow in 1882, and extends down along Amos Bayou for 5 miles, thence across to the south bank of Cypress Creek and along this stream to near the bank of the Mississippi at station 400 (426 R.); thence the levee line extends along the Mississippi River to the lower limits of the third district in Louisiana, immediately opposite Warrenton, Miss. (606 R.), a distance of 172.7 miles. There are 83.5 miles of levee in Arkansas and 89.2 miles in Louisiana.

The total length of levee line included in the district May 1, 1905, is 190.2 miles.

The gap between the Arkansas River and the Mississippi River levee lines when the present contracts are completed will be reduced to about 3.5 miles. The Arkansas River line should be extended as soon as possible to the high ground on the bank of Redfork Bayou about station 1010. This would still leave a gap of 1.5 miles between the two levees, which would afford ample section to pass any floods from Cypress Creek or that may be due to crevasses that might occur in the Arkansas River levees while the Mississippi is low. The end of the Arkansas River levee as contracted for is about the middle of the low swamp between the high ground on Arkansas River and the high ground on Redfork Bayou, thus if the crossing is not extended to the high ground the full effect of the extensions already provided for will not be obtained. It is estimated that if the Arkansas River levee is extended to station 1010 practically all the outflow around the head of the Mississippi system would be cut off up to about 52 feet on the Arkansas City gauge and the area subject to overflow between the two systems would be greatly reduced.

The following table shows new levees constructed to cover caving banks, also the yardage abandoned in the old levee line and the changes in length:

[In Louisiana.]

Locality.	Miles below Cairo.	Stations.			Length.		Cubic yards thrown out.
		Beginning.	End new levee.	End old levee.	New levee.	Old levee.	
					Feet.	*Feet.*	
Atherton	557 R.	2110	2243+15	2219	13,315	10,900	234,300
Biggs	604 R.	4452+50	4512+82	4524+29	9,032	7,179	419,300
Total					22,347	18,079	653,600

The net change of length amounts to a lengthening of 4,268 feet, equal to 0.8 of a mile.

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The following table shows the yardage added to the levees during the period and the total yardage May 1, 1905:

	Arkansas River levees.	Mississippi levee—		Total.
		In Arkansas.	In Louisiana.	
	Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
In place May 1, 1904	1,111,285	13,594,325	16,078,516	30,784,126
Added during year—				
By the United States	532,507	175,992	966,798	1,675,297
By the levee boards		140,336	520,147	660,483
Total	1,643,792	13,910,653	17,565,461	33,119,906
Lost by levees abandoned			653,600	653,600
In levee May 1, 1905	1,643,792	13,910,653	16,911,861	32,466,306

The United States has constructed altogether in this district since 1882, 24,308,808 cubic yards. Of the total yardage in place, the United States has built about 60 per cent and the levee boards 40 per cent.

CONSTRUCTION.

At the beginning of the year there were no uncompleted contracts in force.

On May 1, 1904, a project for the expenditure of the 1904–5 allotment had been adopted and contracts for levee work let as follows:

Station.	Miles below Cairo.	Kind of work.	Net grade proposed.	Estimated yardage.	Contractor.
			Feet.[a]		
500–655	Ark. River	Enlargement	2	108,371	J. G. Sessions.
2580–3760	497 R	Topping	2	46,410	Ben Talley & Co.
3760–3950	512 R	Enlargement	3	124,947	Do.
1539–1810	545 R	do	2	159,093	Do.
4459–4549	605 R	New levee	3	489,567	H. Dalhoff.

[a] Above 1903 high water.

The enlargement and new levee are standard section, the topping designed to be temporary, with about 2-foot crown and variable slopes.

The river remained at a stage sufficient to flood nearly all of the borrow pits along the levee until late in July, thus delaying active operations on the above contracts, except stations 3760–3950, on which work was commenced in June.

In July the project covering the expenditure of the 1905–6 allotment was adopted. This work being authorized by Congress in anticipation of the funds becoming available July 1, 1905, the work was let on a cash basis, the various levee boards agreeing to obtain the cash to advance to the contractors for work done and to charge no interest for the amounts so advanced. The proposals were received July 28, and contracts were let as follows:

Station.	Miles below Cairo.	Kind of work.	Net grade proposed.	Estimated yardage.	Contractor.
			Feet.[a]		
0–500	Ark. River	Enlargement	2	240,000	Cary Bros.
783–928	do	New levee	2	521,883	McCadden, Morgan & Co.
600–677	480 R	Topping	2	4,635	Talley-Bates Construction Co.
2080–2185	557 R	New levee	2	318,092	Donaven & Daley.
2860–3026	576 R	Topping	3	31,199	Do.
3335–3495	583 R	do	3	17,963	Do.

[a] Above 1903 high water.

The Arkansas River enlargement to be constructed with 6-foot crown, 2½ to 1 front, and 3 to 1 back slopes; the new levee extension to have 6-foot crown, 2 to 1 front, and 3 to 1 back slopes. The topping stations 600–677 to be temporary, with 2 to 3 foot crown and variable slopes. The new levee stations 2080–2185 to be standard section without banquette. The last two sections of topping to be constructed with 4-foot crown, 2 to 1 front, and 3 to 1 back slopes.

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All contracts under both projects were well under way by the latter part of August except the Arkansas River extension, stations 783–926, and the Biggs loop, stations 4459–4549 (605 R.). The contractors were very slow getting to work on the above two contracts. It was late in September before their forces were well organized and work started.

The weather conditions were exceptionally good until February 1. Since that date rains have been frequent and excessive throughout the district. (See rainfall table for period in report of Assistant Engineer E. C. Tollinger for Lower Yazoo levee district.) Labor has been very scarce along the entire line, and especially so on the Arkansas River extension and the Biggs loop contracts. At the latter place it was absolutely necessary to complete the new levee before the high-water season on account of the river having caved to within 30 feet of the old levee in October, making it practically certain that the old levee would be caved into. The contractor, H. Dalhoff, pushed the work very energetically and spared no expense in an effort to complete within contract time (February 1, 1905). At one time there were over 400 teams at work. In order to be reasonably sure of having a working force the contractor had to regularly ship large consignments of labor from St. Louis.

The labor problem is growing more serious each year. Throughout the working season, on an average, at least 25 per cent of the teams available for work along the line were not at work on account of lack of teamsters. Some contractors fared much worse than others. McCadden, Morgan & Co., on the Arkansas River extension, and their subcontractors averaged only about 50 per cent of their available teams at work. It was largely due to their inability to obtain labor and keep it that they were unable to complete this work. The above condition is responsible for not completing each of the contracts carried over.

The list of uncompleted contracts and yardage remaining to be placed is given below:

Station.	Miles below Cairo.	Kind of work.	In place May 1, 1905.	To be placed May 1, 1905.	Contractor.
			Cubic yds.	*Cubic yds.*	
0–500	Ark. R.	Enlargement	188,250	51,750	Cary Bros.
783–926	Ark. R.	New levee	235,886	285,997	McCadden, Morgan & Co.
1539–1810	545 R	Enlargement	110,604	49,116	Ben Talley & Co.
Total				386,863	

Work is practically at a standstill on each of the above contracts on account of the river in March and April coming just high enough to flood the pits along each contract.

Methods of construction.—There has been no change in the methods of construction, except the abandonment of the steam traction engine as a means of hauling the elevating graders by most of the contractors heretofore using them. The elevating grader drawn by teams in connection with dump wagons is still used with increasing success on work through open fields where the material is not too sandy. There is a class of material, a heavy, sticky gumbo, which these machines handle readily, plowing up great strips, which break off into slabs and are dumped into the levee in this shape. It has been noted that where the section of the levee has been so constructed there has been an excessive amount of shrinkage, and the shrinkage is very uneven.

A table accompanies this report, showing cost and all construction details of work during the year.

The average cost of all work let by the United States in this district covering the period was 20.1 cents per cubic yard, which is higher than usual, due to the construction of Biggs loop, a difficult piece of work containing nearly 500,000 cubic yards, the contract price of which was 24.6 cents per cubic yard.

Levee board construction.—The Desha levee board had the enlargement of the levee in front of Arkansas City stations 897–934 (438 R.) under contract at the beginning of the season. Work was prosecuted on same by a small force during the period, but owing to the low flat at the lower end of the contract being under water, material could not be obtained to complete two of the stations, hence the contract has not been completed.

The Tensas Basin levee board let two contracts for enlargement on July 28, as follows:

Stations 1511–1625 (450 R.), 90,000 cubic yards, M. J. Roach & Co., contractors.
Stations 1854–1910 (468 R.), 40,000 cubic yards, M. J. Roach & Co., contractors.
Both contracts were finished before February 1.

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At the request of the levee boards, engineering and inspection was furnished for the above work free of charge, it being possible to do so without additional cost to the Government.

In Louisiana the State and the fifth Louisiana levee board undertook contracts amounting to approximately 750,000 cubic yards. All of their work with the exception of two contracts, both recently let, has been completed. A statement accompanies this report, giving the list and yardages and cost of all levee board contracts in the district.

REPAIRS AND MAINTENANCE.

The flood stage of 1904 caused some damage from wave wash, especially along exposed reaches and on newly completed work not yet sodded over. In July it was decided to start a force of about 14 teams, hired by the day, and repair the above reaches. W. E. Cassidy's force was employed at the rate of $4.50 per team day and work was commenced on the Leland dike (R. 470). Minor repairs were undertaken along various portions of the line from time to time, utilizing the forces at work on regular contract work where repairs were needed.

The following table shows in detail all repairs undertaken, together with the cost of same and the locality of the work.

Stations.	Miles below Cairo.	Nature of work.	Cubic yards handled.	Cost.	Price per cubic yard.
					Cents.
390–430	Ark. R.	Restoring wave wash on accepted levee work.	1,761	$853.88	48.5
689–704	Ark. R.	Emergency topping			
330	Ark. R.	Clearing barge roads from levee to river		30.00	
740	Ark. R.				
1782	466 R	Topping spur levee	794	235.75	30.0
Dike 0–63	470 R	Restoring rain and wave wash, and resodding.	11,560	3,302.62	29.1
2262–2365	486 R				
2495–2505	490 R				
Dike 0–63	470 R	Building 2 permeable brush and pole dikes, repairing revetment at end, cutting down 100 feet old levee		420.89	
4045	516 R	Rebuilding road crossing and repairs to levee.	14,056	2,625.75	18.6
164–196	522 R	Restoring rain and wave wash			
1362–1419	574 R				
4323	602 R	Rebuilding road crossing	500	159.50	31.9
Total				7,628.39	

Material placed, 28,671 cubic yards; cost, $7,177.50; average cost per cubic yard, 25 cents.

Weed cutting.—The fifth Louisiana levee board undertook all the weed cutting necessary in Louisiana. Most of the levees in Arkansas are well sodded and pastured and no weed cutting was necessary until late in the season, except along a few reaches inclosed in fields and on which stock is not allowed to run. Contracts were let informally, and the work done as needed. The following statement shows the weed cutting undertaken, the contractors therefor, and the cost.

Station.	Contractor.	Number of stations in reach.	Price per station.	Cost.
			Cents.	
Arkansas R. 655–776	Webb Holmes	121.0	40	$48.40
999–1270	Mack Anderson	271.0	40	108.40
1270–1620	do	350.0	20	70.00
1620–1860	do	240.0	40	96.00
1860–1910	do	50.0	20	10.00
1910–1961	do	51.0	40	20.40
1961+50–2174+70	T. N. Llewellyn	213.2	40	85.28
Dike 0–63+50	do	63.5	50	31.75
2267a–2583	do	266.0	35	92.10
2061–2157[a]	Mack Anderson	96.0	40	38.40
Dike 0–58[a]	do	58.0	40	23.20
Total		1,779.7		624.93

[a] Cut second time.

Average cost per station, 35.1 cents.

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Sodding.—Very little resodding was necessary last season. The two reaches noted below have been sodded this season, and it is proposed to resod and redress a considerable proportion of the work finished in January and February.

Station.	Number of stations sodded.	Price per station.	Cost.	Remarks.
In Arkansas:				
1020–1240	220	$1.30	$286.26	Crown and river side slope.
Dike 0–60	60	2.76	165.70	Both sides sodded.
Total			451.96	

HIGH-WATER MAINTENANCE.

At the date of the last annual report the river was still above the danger line at all stations in the third district. All high-water work had been suspended, with the exception of a small force at work on the Leland dike, strengthening and maintaining the revetment at the end which showed a disposition to fail on account of scour; the force was disbanded on May 31. The cost of this party amounted to $370.13, which constitutes all the high-water expense for the period. It is a noteworthy fact that while at no time in 1904 did the river attain an extreme high stage, yet throughout the district the river continued well up against the slopes of the levees from March 21 to July 26, a period of over one hundred days.

The Arkansas River reached a stage at Little Rock of 29.4 on June 11, which was only 1.8 feet below the highest on record in recent years. The flood was of long duration, and was followed by a second freshet late in July, almost equal to the first. A crevasse occurred at Sarrassa, in Lincoln County, during the first rise, which flooded all of the Arkansas Valley and did some damage in the Redfork district, and, on account of the second rise in July, all farming operations in the overflowed area had to be abandoned for the year. The water was well up on the levees below Redfork, but on account of the relatively low stage in the Mississippi no great damage was done to these levees, and the water was not high enough to cause uneasiness.

The maximum stage the river has attained this spring registered 39.8 feet on the Arkansas City gauge, which was more than 2 feet below danger line, yet this was high enough to come well up on all levees over 14 feet high, and to flood nearly all the borrow pits along the levees and practically suspend all work. From the present indications there is no danger of an extreme high water this year.

SURVEYS.

Surveys were made as follows by parties specially organized for the purpose:

Shore lines located in June, 1904:	Miles.
Lucca to Island 78 (425–432 R.)	7
Gaines to Panther Forest (450–453 R.)	3
Mathews Bend (507–510 R.)	3
Atherton Front (557–560 R.)	3
Sparta to Duckport (588–590 R.)	2
Total	18

Preliminary location surveys for new levees:
Atherton (557 R.).
Arkansas River extension (405 R.).
Above Arkansas City (430 R.).

Ordinary level lines run over top of 85 miles of levee in Arkansas and Louisiana.

The cost of all of the above work amounted to $1,792.50.

In addition to the above the following surveys were made by the regular engineering forces in the field without additional expense to the United States:

Final location surveys for new levees as follows: Arkansas River extension, Atherton loop (557 R.), Biggs loop (605 R.), also a location line was run for an additional extension of the Arkansas River levees 3¼ miles to Cypress Creek. Distances have been measured monthly to caving banks along all levees close enough to be endangered by the caving.

BANK LINES.

The rate of caving for this season along all the reaches threatening the levee line, with the exception of two localities, has been considerably less than it had been for

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several years. Below is given briefly the results of the surveys and observations made during the year.

Lucca to Island 78 (425–432 R.).—The change along this entire reach since May 1, 1904, has been very slight; caving has continued slowly. There has been practically no change, however, during the period opposite to the closest points to the levee, stations 483, 651, and 735. A cave of about 150 feet occurred opposite to station 631, making the distance 375 feet from shore to levee at that point. A survey was made, as noted above, for new levees with permanent location to cover the threatened portion of the levees south of station 600. An estimate of the most desirable line to build is given elsewhere. Unless the caving shows an increased activity in May and June it is not possible that a new levee will have to be built this season.

Gaines to Panther Forest (450–453 R.).—The caving has threatened the angles at stations 1,530 and 1,730 for the past two years. Caving has continued slowly in the bend, but for the period there has been very slight change opposite either of the above points.

Mathews Bend (507–510 R.).—Caving has continued slowly throughout this bend; at the closest point to the levee, station 3732, the distance in June, 1904, was 465 feet, and in March, 1905, the distance measured 438 feet, a cave of 27 feet during the period. The caving has been much more active above and below this point, and a recent personal inspection seems to indicate that it will continue with increased activity for the next two months. It is possible that a new levee will have to be provided before the next high-water season; however, unless the caving increases materially for the next two months it can be postponed for another year.

Atherton front (557–560 R.).—This is one of the bends where the caving has continued very active throughout the entire period. The survey of June, 1904, indicated that the levee line would cave off within the year; hence, a new loop here was provided for in the project for the expenditure of the 1905–6 anticipated allotment. The new levee was completed in March, and the bank caved into the old levee for about 2,000 feet during the same month. The new levee will make this point safe for some time.

Sparta to Duckport (588–590 R.).—Caving has continued slowly along this reach, working downstream; there are three angles at about equal distance from the river bank, stations 3680, 3715, and 3762, which may be threatened within a year. A short temporary levee can cover either one, if needed; hence, it is considered safe to postpone the construction of a new levee in this locality.

Biggs to Reids (604–606 R.).—Caving has continued very rapidly in this bend for the past two years. A new levee was provided for in the 1904–5 project, which was completed last March. The old levee was breached during the same month. If the present rate of caving continues the new levee will be threatened within six years. In the event the caving does continue, it will be more economical to revet about 7,500 feet covering the new levee just completed, as a location back of this will be very difficult and costly.

The shore measurements of February indicated that the angle at station 4414 + 88 would be breached within another season. The Louisiana State board of engineers contracted for a new levee covering this point, and work has been started on same.

CONDITION OF LEVEE LINE AND ESTIMATE FOR CONTINUED CONSTRUCTION.

The following table gives the condition of the levee line and height with reference to the 1903 high water, after completion of all the 1904–5 contracts:

Condition.	Arkansas River levees.		Mississippi River levees—			
			In Arkansas.		In Louisiana.	
	Miles.	Per cent.	Miles.	Per cent.	Miles.	Per cent.
0 to 1 foot above 1903 high water	.....	.....	[a]24.5	29.4	.....	.....
1 to 2 feet above 1903 high water	.....	.....	11.2	13.4	9.5	10.7
2 inches or more above and below Commission grade	[b]17.5	100.0	47.8	57.2	[c]61.5	68.9
Up to Commission grade	.....	.....	.....	.....	18.2	20.4
Total	17.5	100.0	83.5	100.0	89.2	100.0
Levees with banquette	.....	.....	27.0	32.3	52.4	58.8

[a] 22.5 miles has been topped with emergency topping 2 feet above 1903 high water, with 2 to 3 foot crown and variable slopes.

[b] 10 miles has section of 6-foot crown, 3 to 1 back and 2½ to 1 front slopes. 3 miles has section of 6-foot crown, 3 to 1 back and 2 to 1 front slopes.

[c] 11.4 deficient in section, with topping 4-foot crown, 3 to 1 back and 2 to 1 front slopes.

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The policy of topping all of the extremely low reaches not badly exposed to wave wash and enlarging the exposed levee with standard section has been carried out as the above table shows. It is recommended that this policy be still adhered to, and the following list of work necessary to bring up the balance of the line remaining below the grade of 2 feet above the 1903 water is estimated on this basis.

Station.	Miles below Cairo.	Nature of work.	Estimated contents.
			Cubic yards
750–890	433 R.	Topping	10,000
935–1020	438 R.	Enlargement	80,000
1625–1720	450 R.	.....do	75,000
1720–1855	451 R.	Topping	15,000
1910–1940	468 R.	.....do	3,000
2562–3670	487 R.	Enlargement	555,000
755–900	530 R.	.....do	120,000
1060–1100	535 R.	.....do	30,000
Total			888,000

The above yardage at an estimated cost of 20 cents will amount to $177,600.

All of the above work should be undertaken as soon as possible.

When finished, the entire line would be to sufficient grade and section to withstand high water of from 1 to 2 feet above the highest floods with comparative safety.

It is hoped that the following amounts may be raised to devote to the above work by the following levee boards:

Tensas Basin levee board	$50,000
Chicot levee board	10,000
Total	60,000

This would leave a balance of about $120,000 to be provided for from the allotment now available.

Estimate to Commission grade.—This is based on a grade fixed by the Mississippi River Commission in 1898, which throughout this district averages 6 feet above the 1897 high water. The 1903 water failed to parallel the 1897 water in many instances throughout the district, especially from Greenville south to below Lake Providence.

Along this reach, if present conditions remain, the Commission grade will have to be raised very materially. The following estimate is the same as has been carried from year to year, with the correction made allowing for all material that has been placed during the year and work now under contract:

Station.	Enlargement.	Banquette.	New levees and extensions.	Total.
	Cub. yards.	*Cub. yards.*	*Cub. yards.*	*Cub. yards.*
0–926, Arkansas River levee	1,100,000	516,000	.....	1,616,000
926–1010, Arkansas River levee	.....	84,000	600,000	684,000
0–269, Amos Bayou levee	175,000	.....	.....	175,000
0–4210, levees in Arkansas	3,850,000	1,750,000	2,050,000	7,650,000
0–4619, levees in Louisiana	3,900,000	2,107,000	400,000	6,407,000
Total	9,025,000	4,457,000	3,050,000	16,532,000

The above total yardage at an estimated cost of 20 cents per cubic yard will amount to $3,306,400.

Material in place, 32,466,306=66.2 per cent; to be placed, 16,532,000=33.8 per cent.

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New loops.—Prospects are very good that there will not have to be any new levees built to cover caving banks during the coming season. The following table shows the more threatened localities and, approximately, the date a new levee will be necessary, if the present rate of caving continues, and the estimated cost of same:

Station.	Miles below Cairo.	Estimated contents.	Estimated cost.	When probably necessary.
		Cu. yards.		
424–529	428 R.	300,000	$60,000	1907–8
600–890	430 R.	850,000	136,000	1906–7
1490–1560	450 R.	250,000	40,000	1907–8
1700–1760	452 R.	300,000	66,000	1906–7
3671–3750	508 R.	350,000	63,000	1906–7
3650–3780	589 R.	400,000	64,000	1906–7

Estimate based on grade 2 feet above 1903 high water, standard section without banquette.

Spur levees.—A spur 6,350 feet long was constructed on Leland Neck (470 R) in 1903–4, designed to prevent a cut-off from surface scour, which was narrowly averted during the 1903 high water. The spur was constructed with 6-foot crown and 2½ to 1 slopes. The material is very silty and sandy, and, along its entire length, especially on the upper side, it is exposed to severe wave-wash during flood stages. With an extreme high water a severe windstorm would greatly damage the steep slopes and might cause the spur to breach; hence it is urgently recommended that the spur be built to permanent grade and section of at least 3 to 1 slope on the upper side, at the earliest possible moment. This would require the placing of about 85,000 cubic yards of enlargement, estimated to cost 16 cents, amounting to $13,600.

The policy as to whether this spur is to be extended farther out on the point should be decided on, and all the work of protecting the end from erosion and scour, and of preventing wave-wash, should be made of a permanent nature. It is recommended that the spur be extended 5,000 feet, estimated to require 170,000 cubic yards, at 15 cents, amounting to $25,500.

Considerable study and investigation has been made during the period bearing on the effect of extreme high waters flowing across points unobstructed and otherwise, and the advisability of constructing spur levees extending from the main line of levee out on such points in order to force practically all the water to flow around the channel of the river. Several special reports have been made and submitted to your office on the subject. While no definite conclusion in regard to the construction of any of the spurs has been arrived at, it is practically unanimously agreed that the abandonment of the points and the great rush of water across them is generally detrimental to levee grades and to the river channel.

Arkansas River extension levee.—As noted at the beginning of this report, it is recommended that this extension be made from station 926 to station 1010 as soon as possible. This work is estimated to contain 350,000 cubic yards, which, at 20 cents, amounts to $70,000.

Minor repairs, weed cutting, sodding, etc.—The heavy rains in March and April caused all the newly completed work of a sandy material to wash badly. A great amount of the sod put in during the winter months was killed by the severe cold weather in February. This will all have to be renewed.

Weeds should be cut the first time in June, overreaches not well sodded and not pastured, and nearly the entire line of the levee should be cut over in August and September. This entire work is estimated to cost $10,000.

Surveys.—The usual shore line surveys should be made, including the channel surveys, as recommended in last year's report. (See Report Mississippi River Commission, 1904, p. 221.) Owing to the numerous changes that have been made in the levee line since the last general survey (1901), it is recommended that a new general survey be made during the months of October and November this year. This survey to include the renewing of all local high-water gauges, the new gauges to be set and marked—referred to the Memphis datum. The iron bench marks should be renewed where they have been destroyed, but the enumeration should not be changed for the present. The survey should include an accurate transit line over the entire district, and all property and land lines should be connected to as well as the permanent Mississippi River Commission and Coast Survey points. Such a survey is estimated to cost about $15 per mile, or about $3,000 for this levee district

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GENERAL REMARKS AND RECOMMENDATIONS.

During the period a special effort has been made to impress on the local levee authorities the necessity for preserving the levees free from all depredations, abuses, and uses for other purposes than that for which they are intended. Their attention has been directed to the Federal statutes bearing on the subject, and all uses and abuses contrary thereto have been ordered discontinued. All of the local authorities have agreed to enforce the State laws, which, if enforced, would gain the desired end. In some localities they are succeeding very well, but in others it looks as if Federal laws will have to be invoked.

In Arkansas very little of the right of way on which the levees have been built has been secured in a legal manner, the levees have been built on their location simply by the consent of the property owners, hence in some instances the right is implied by some to fence in the levees through their property. If the survey recommended above is made a description of all the levee rights of way should be drawn up and the levee boards directed to procure same legally.

A more systematic organization for the constant maintenance of the levee line should be adopted either by the local levee boards or by the United States. There is so much minor work that should be done almost continuously along the levees each year, and the work should be done simultaneously along the whole line in season. Permanent forces should be organized somewhat similar to the familiar railroad section gangs, except that the sections on the levee could be made much longer than the average length of the railroad section. Such gangs could be made the nucleus of a high-water organization in the spring, and immediately after the recession of the water could perform all the minor repairs incident to a high water, such as removing drift wood, resodding where necessary, and collecting and storing all tools and material. After this work is done it would be time to cut the weeds the first time and keep the levee along their section in a state of maximum efficiency. They could also patrol the levee at all times, seeing that all laws pertaining to the preservation thereto are enforced, and could generally assist in any other work, such as engineering, levee inspection, etc. Such an organization, based on sections of 30 miles, is estimated to cost $100 per mile per annum fixed cost. When there is very much repair work to be done, the foreman could hire additional teams and men and the cost then would be in proportion to the amount of work done. The fixed cost would be more than saved, the gangs serving as a high-water organization during years of moderate high water. For each section there should be built permanent quarters, warehouse, etc., for use, especially during high-water years.

The completion of the Memphis, Helena and Louisiana Railroad along the west bank of the river will be of great benefit to the levees, affording better facilities for the proper inspection, and especially during high water the facilities for obtaining labor and material and the distribution of same will be greatly simplified. This road is now in operation from its crossing of the Arkansas River levees to the lower end of the district.

The expenditure of Government funds in this district during the period May 1, 1904, to April 30, 1905, aggregates as follows:

Designation.	Expenditures.	Per cent.
Construction	[a] $314,001.64	91.6
Repairs and maintenance	9,134.21	2.7
Engineering, surveys, etc	19,820.72	5.7
Total	342,956.57	100.0

[a] Includes amount of estimates on the contracts under the 1905-6 anticipated allotment, money for which will be available July 1, 1905.

Engineering was furnished for levee board work amounting to $33,273.50, which, if credited to the above statement, the cost of engineering would be 5.1 per cent.

The following blueprint and statements accompany this report: Profile showing top of levee and 1897 and 1903 high-water slopes; statement of levee constructed by the United States; statement of levee constructed by levee boards.

Respectfully submitted.

A. MILLER TODD,
Assistant Engineer.

Capt. G. M. HOFFMAN,
Corps of Engineers.

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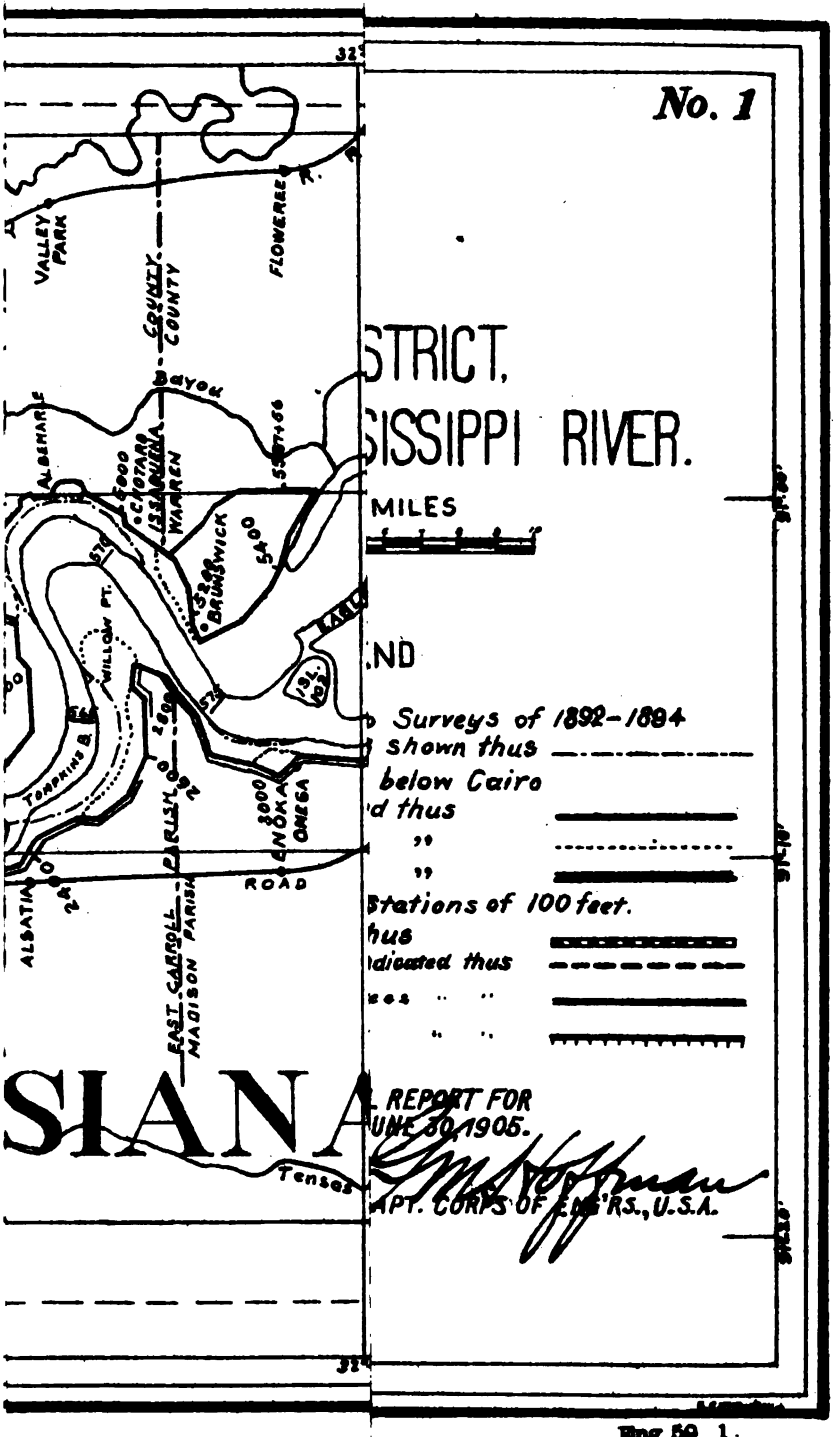

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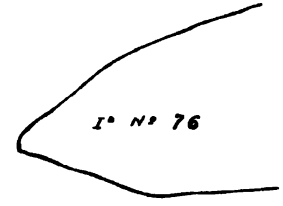

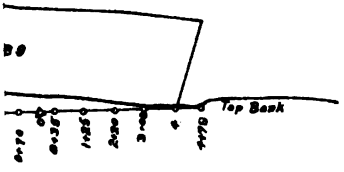

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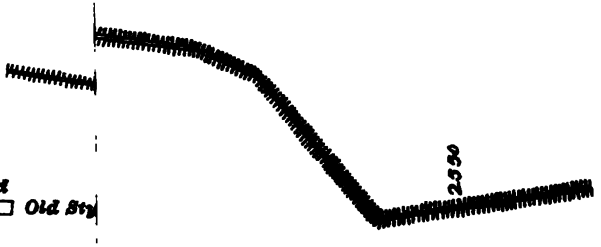

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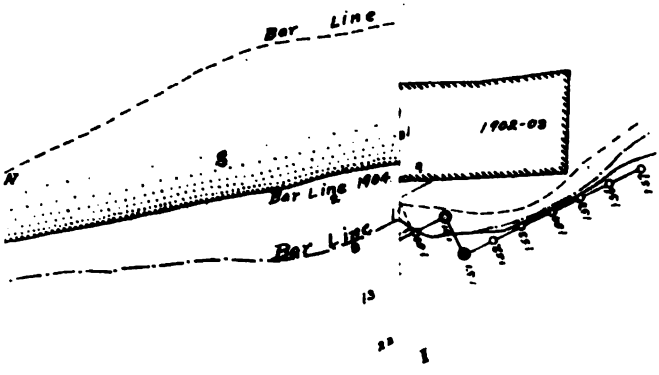

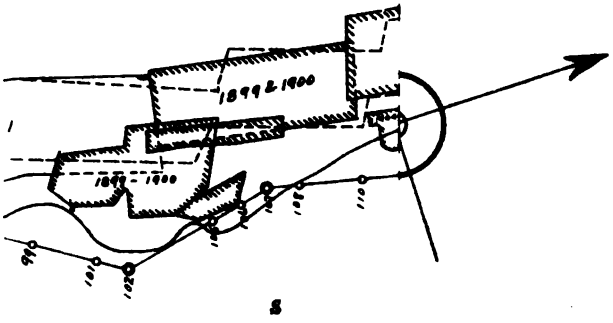

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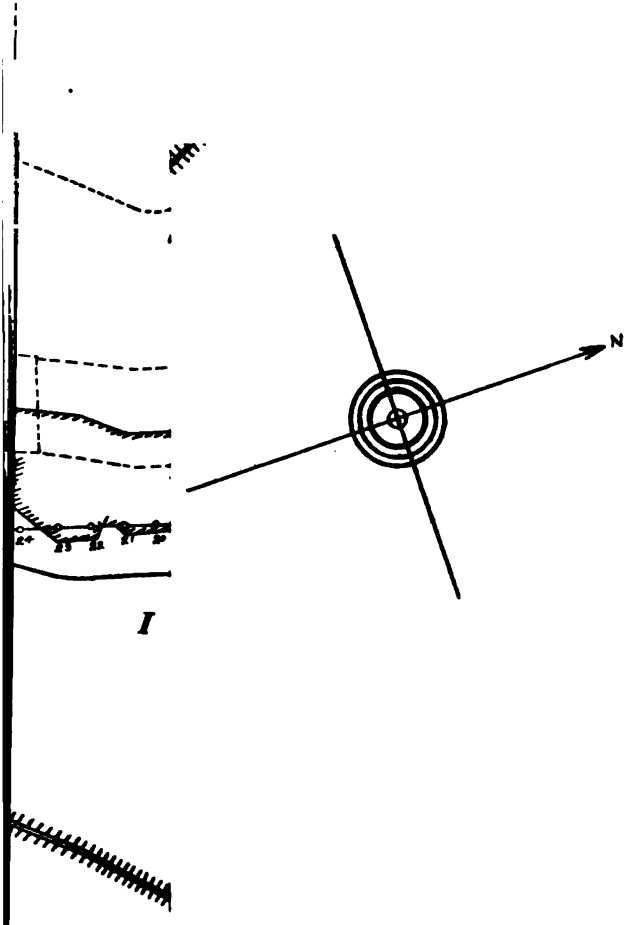

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I.M.R.

THIRD DISTRICT

MAP

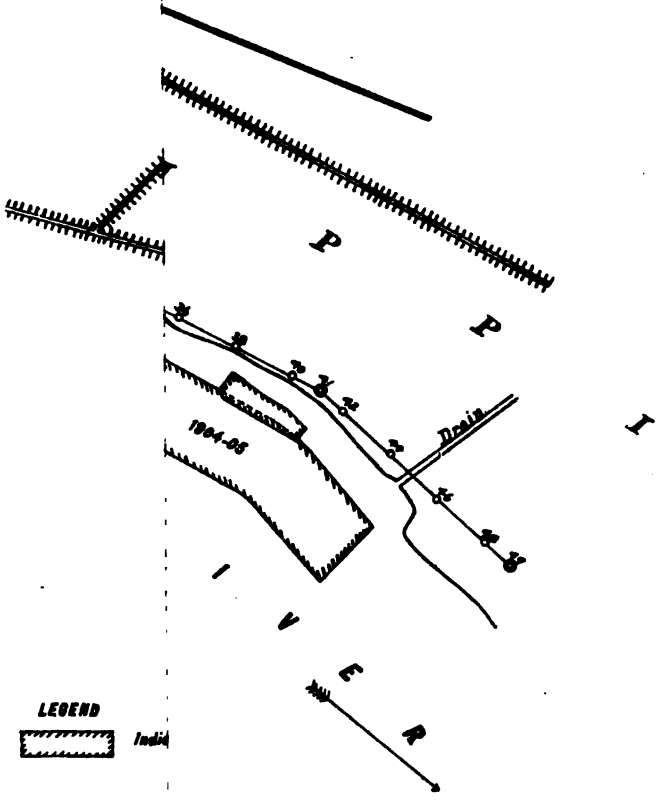
WING EFFECTIVE REVETMENT

AT

LONGWOOD, MISS.

Scale

SEPTEMBER, 1904.



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LONGWOOD, MISS.

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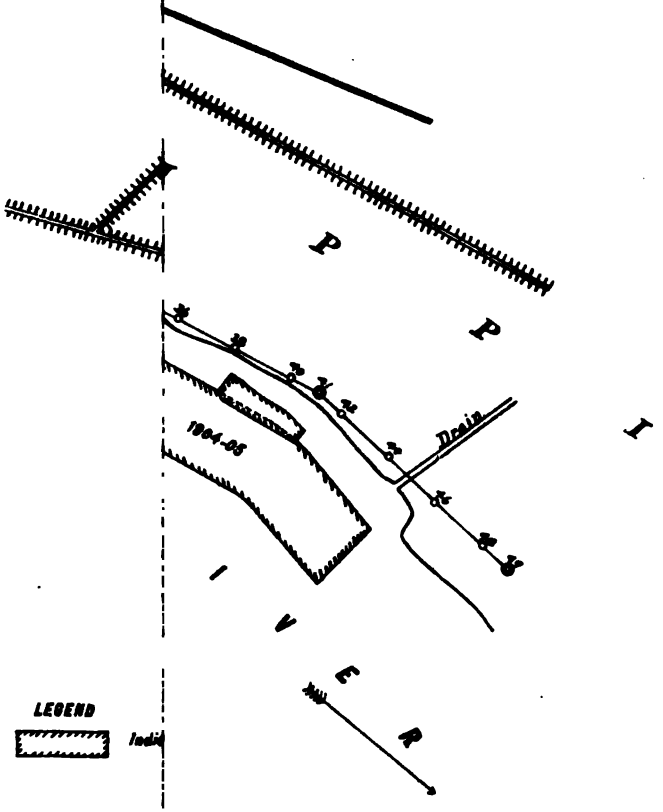

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MAP

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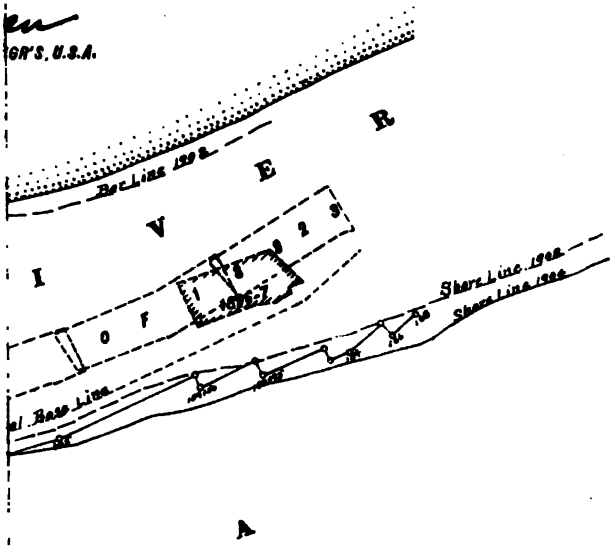

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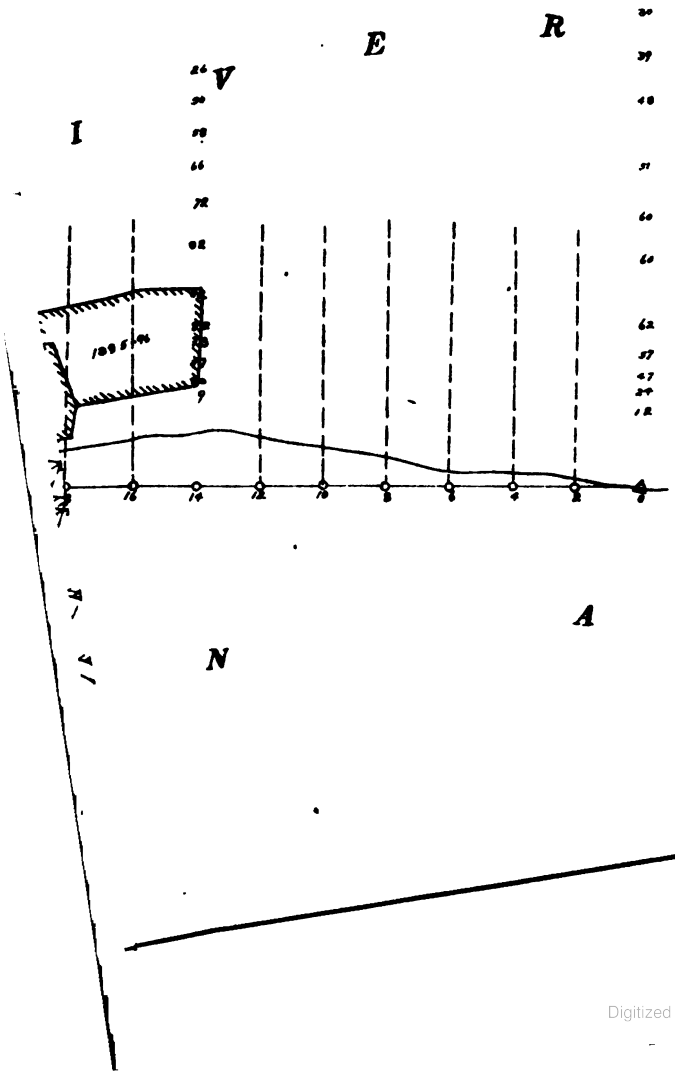

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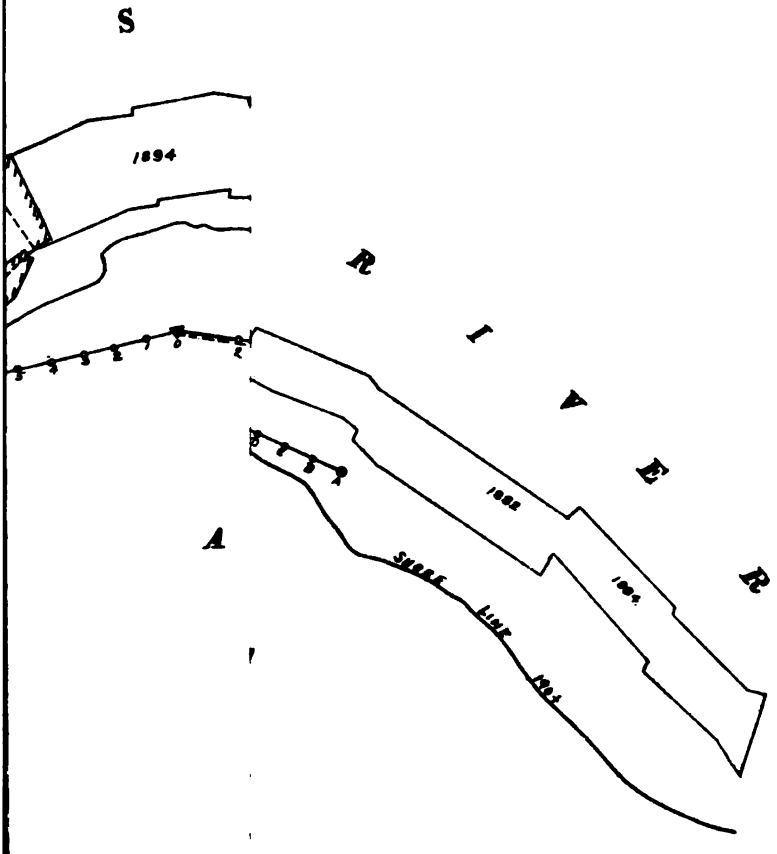

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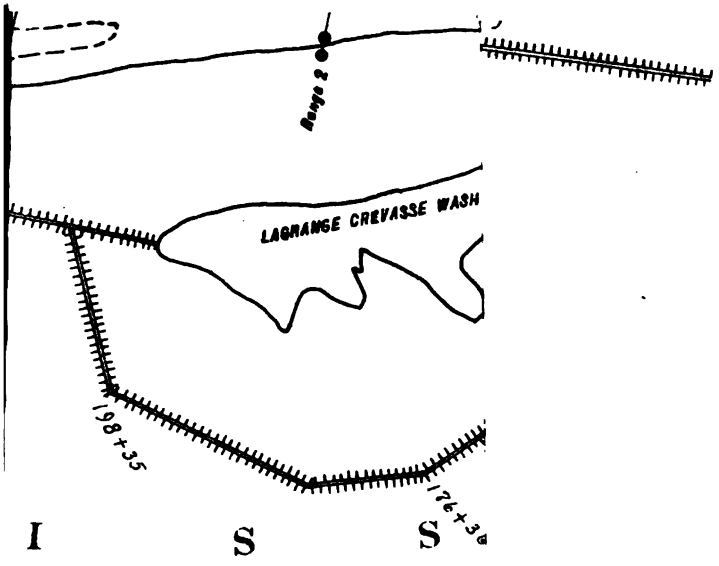

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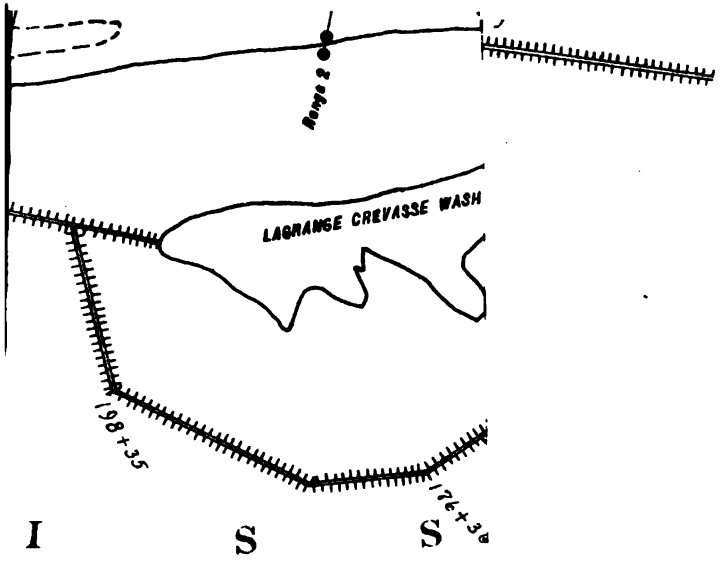

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Levee work in Upper Tensas levee district, May 1, 1904, to May 1, 1905.

[E. = Enlargement; N. = New work; T. = Topping.]

Station.	Miles below Cairo.	Contractors.	Cubic yards in contract.	Cubic yards placed during year.	Total laborers.	Total teams.	Total scrapers.
0–500	A. R.	Cary Bros	240,000	188,250	9,009	6,174	4,272
500–655	A. R.	Jno. G. Sessions	108,371	108,371	4,989	2,932	1,961
783–833	A. R.	McCadden, Morgan & Co	178,883	113,789	7,337	4,390	2,739
833–883	A. R.	do	168,000	87,951	5,514	3,597	2,281
883–926	A. R.	do	175,000	34,146	2,381	1,511	934
600–677	430	Talley-Bates Construction Co.	4,635	4,635	675	485	329
2580–3760	497	Ben Talley & Co	46,410	46,410	3,068	2,135	1,368
3760–3950	512	do	124,947	124,947	6,328	4,709	3,074
1539–1810	545	do	159,093	109,977	6,898	4,650	2,796
2080–2185	557	Donaven & Daley	318,092	318,092	13,617	[a] 10,730	[a] 6,505
2860–3026	576	do	31,199	31,199	2,100	1,608	1,044
3335–3495	583	do	17,963	17,963	1,282	977	599
4159–4489	604	H. Dalhoff	146,713	146,713	8,074	5,798	3,544
4489–4519	605	do	167,247	167,347	10,566	7,871	4,716
4519–4549	606	do	175,507	175,507	13,291	9,417	5,826
Total			2,062,160	1,675,297			

Station.	Miles below Cairo.	Yards per team.	Yards per scraper.	Price per cubic yard.	Average height.	Average haul.	Kind of work.
				Cents.	*Feet.*	*Feet.*	
0–500	A. R.	30	44	15.0	11.9	275	E.
500–655	A. R.	37	56	17.74	10.5	250	E.
783–833	A. R.	26	42	19¼	17.2	300	N.
833–883	A. R.	24	39	19¼	16.6	300	N.
883–926	A. R.	23	37	19¼	17.5	300	N.
600–677	430	10	14	38.0	18.7	500	T.
2580–3760	497	22	34	20.0	15.6	175	T.
3760–3950	512	25	41	20.0	13.6	200	E.
1539–1810	545	24	39	18¼	18.7	200	E.
2080–2185	557	30	49	15.9	12.7	275	N.
2860–3026	576	19	30	15.9	18.2	200	T.
3335–3495	583	18	30	15.9	17.0	250	T.
4159–4489	604	25	41	24.6	18.2	210	N.
4489–4519	605	21	35	24.6	19.5	215	N.
4519–4549	606	19	30	24.6	20.2	215	N.

[a] Graders and wagons used; graders estimated as 7 teams and wagons as 2 scrapers.

Table showing levee construction by the levee boards in Arkansas and Louisiana from May 1, 1904, to May 1, 1905.

[N. = New work; E. = Enlargement; B. = Banquette; T. = Topping; S. = Spur; W. = Wave-wash; R. = Repairs.

DESHA LEVEE BOARD.

Stations.	Miles below Cairo.	Cubic yards in contract.	Cubic yards placed during year.	Price per cubic yard.	Total expended.	Kind of work.
				Cents.		
897–934+	438	30,300	10,334	30.0	$3,100.20	E.

TENSAS BASIN LEVEE BOARD.

1511–1625+	450	88,273	88,273	20.0	$17,654.60	E.
1854–1910	468	41,729	41,729	30.0	12,518.70	E.

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Table showing levee construction by the levee boards in Arkansas and Louisiana from May 1, 1904, to May 1, 1905—Continued.

FIFTH LOUISIANA LEVEE BOARD.

Stations.	Miles below Cairo.	Cubic yards in contract.	Cubic yards placed during year.	Price per cubic yard.	Total expended.	Kind of work.
				Cents.		
256–756+	525	609,549	272,241	16.0	$43,558.56	E.
255	525	5,959	5,959	16.0	954.44	S.
956–1060	533	81,525	81,525	13.875	11,311.59	E.
1127–1166	536	5,520	5,520	14.5	800.40	W.
1159–1190	537	21,230	21,230	14.5	3,078.35	E.
1190–1264	538	41,361	11,471	19.9	2,282.73	E.
1264–1296+	539	19,018	19,018	17.97	3,417.53	E.
1303–1365+	540	24,257	8,457	13.9	1,175.52	B.
1433–1459	542	20,376	20,376	17.97	3,661.57	E.
1458–+44	542	6,105	6,105	17.97	1,097.07	S.
2368–2497	561	107,500	7,000	17.45	1,221.50	E.
2497–2710	564	40,510	28,510	25.0	7,127.50	T. and E
3014–3046	578	97,387	17,087	19.9	3,510.31	N.
4384–4430	600	174,000	15,000	21.0	3,150.00	N.
4546–4550	605	648	648	25.0	162.00	R.

SUMMARY.

In Arkansas		160,302	140,336		$33,273.50
In Louisiana		1,254,945	520,147		86,509.07
Grand total		1,415,247	660,483		119,782.57

APPENDIX 4.

REPORT OF CAPT. J. F. McINDOE, CORPS OF ENGINEERS, ON OPERATIONS IN THE FOURTH DISTRICT.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 1, 1905.

COLONEL: I have the honor to submit the following report upon the work of the fourth district, Mississippi River inprovement, for the period from June 1, 1904, to June 1, 1905.

The fourth district extends from Warrenton, 7½ miles below Vicksburg, Miss., to the Head of Passes, about 13 miles from the Gulf of Mexico, a distance of 452.8 miles by river.

The works include bank protection in Bondurant Chute; bank protection in Kempe Bend; the improvement of the harbors at Natchez, Miss., and Vidalia, La.; improvements at the junction of the Mississippi, Red, and Atchafalaya rivers; improvement of the harbor at New Orleans, La., and the construction, repair, and maintenance of the levee system of the district.

This work was temporarily in charge of Lieut. Col. H. M. Adams, Corps of Engineers, until July 7, 1904, and since that date in charge of Capt. J. F. McIndoe, Corps of Engineers.

BONDURANT CHUTE REVETMENT.

For history of this work, project, and details of its execution, see current summary, also Annual Reports of the Chief of Engineers since 1901.

At the beginning of the fiscal year 2,295 linear feet of revetment, measured parallel to the general shore line, was in place.

The work was in good condition, with the exception of part of the concrete-in-situ upper bank pavement placed in 1900–1901, which was damaged by seepage from Lake Bruen. This excessive seepage converts the bank into a semiliquid mass without sufficient support for the pavement, which breaks up and sinks.

The high water of 1904 scoured away the bank above the mattress sunk in March, 1904, on the salient between the protection work of 1900–1901 and 1902–3, and one of the board mattresses just above this salient was wrecked by the subsidence of the bank.

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The project approved June 17, 1904, for the application of $3,000 allotted from the sundry civil act of April 28, 1904, provided for extension of the revetment about 100 feet upstream to protect a salient that had formed by the gradual wearing away of the unprotected bank, and for repairing the high-water scour of the upper bank above the grade line of the revetment.

Two sections of willow mattresses were sunk, containing 34,500 square feet, at a cost of $0.058 per square foot in place. The mattresses were built on a bar in the vicinity between December 12 and 15, 1904; and as the chute is not accessible to tugs until the Mississippi River reaches a stage of 26 feet on the Vicksburg gauge, sinking of the mattresses had to be deferred. On March 7–8, 1905, the necessary plant for sinking could be moved into the chute, and sinking of mattresses was completed March 14, 1905. One willow mattress, 130 by 150 feet, was sunk at the upper end of the revetment, and the other, 100 by 150 feet, was sunk over the wrecked board mattress.

The high water scour of 1904 at the salient above the mattress sunk last season was protected by concrete blocks for a distance of 50 by 28 feet. All the work projected for this season was successfully completed.

The revetment was extended 145 feet, making the total length 2,440 feet measured parallel to the general shore line. The survey of the bank line was repeated, and the three cross sections laid off at the head of the chute last season were resounded. The survey shows that no general filling up at the head of the chute has taken place since last year and the shore line below the revetment is slowly receding.

The details of this work and its cost are set forth in the appended reports of my assistants, Mr. H. S. Douglas and Mr. E. B. Geddes. Map is herewith (Pl. I), showing the work done and the changes in bank line.

The amount expended from June 30, 1904, to June 30, 1905, is $3,000, distributed as follows:

Office expenses, main office		$290.00
Other administrative expenses		256.89
Construction (hired labor):		
Materials	$701.57	
Wages	1,163.16	
Subsistence	496.38	
		2,361.11
Care of plant		92.00
Total		3,000.00

Money statement.

ALLOTMENT FOR BONDURANT CHUTE.

Amount allotted from sundry civil act approved April 28, 1904	$3,000.00
Amount allotted from sundry civil act of March 3, 1905	2,000.00
	5,000.00
June 30, 1905, amount expended during fiscal year, for maintenance of improvement	3,000.00
July 1, 1905, balance unexpended	2,000.00
Amount (estimated) required for completion of existing project	Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905:	
For works of improvement	$3,000.00
For maintenance of improvement	2,000.00
	5,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

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ABSTRACT OF APPROPRIATIONS.

By act of Congress of—	
March 3, 1899 (sundry civil act), allotted	$20,000
June 13, 1902 (river and harbor act), allotted	10,000
March 3, 1903 (sundry civil act), allotted	5,000
April 28, 1904 (sundry civil act), allotted	3,000
March 3, 1905 (sundry civil act), allotted	2,000
Total	40,000

KEMPE BEND REVETMENT.

For history of this work, project, and details of its execution, see current summary, and Annual Reports of the Chief of Engineers since 1900.

At the beginning of the fiscal year there were three detached sections of revetment in place; Upper Kempe revetment, 883 feet long; Middle Kempe revetment (placed last year to protect the upper end of the Starling Loop levee), 1,395 feet long; and Lower Kempe revetment, 5,315 feet long, making a total length of 7,593 feet of revetted bank, measured parallel to the general shore line.

The project approved June 17, 1904, for the application of $80,000, allotted from the sundry civil act of April 28, 1904, provided:

"(*a*) For placing a mattress revetment similar to that of the past year in the intervals between the three isolated pieces, so as to make the revetment continuous;

"(*b*) For the extension of the revetment placed last year, opposite the upper wing of the Starling Loop levee, up to a 20-foot stage; and,

"(*c*) For repairing the existing revetment."

Mattress construction was begun at Racehorse Island, 8 miles below Vicksburg, on August 12, 1904, and continued until November 11, when the supply of suitable willows became exhausted. Construction of mattresses was then begun at Bruinsburg bar, 45 miles below Racehorse Island and 15 miles from Kempe. The supply of labor was short at all stages of the work. The construction of the 1,333,950 square feet of mattresses required for the season's work at Kempe, Bondurant Chute, and Giles Bend was not completed until December 20, 1904.

For want of experienced white laborers, sinking of mattresses in Kempe Bend had to be deferred. Sinking, however, was begun on November 6, and was successfully completed on December 29, 1904.

For the season's work there was required in Kempe Bend a total of 836,650 square feet of mattresses, including 102,000 square feet used in making the junction between the subaqueous work and upper bank paving. The cost per square foot in place was $0.0624, made up as follows: Construction, $0.0299; towing, $0.0017; sinking, $0.0308.

The mattresses for this work were 250 feet wide, and on account of the swift current in Kempe Bend were made in sections 100 by 120 feet and 50 by 120 feet, and placed by the three tugs in position for sinking.

During previous years the upper bank had been graded and paved from section 23 to about section 21 (Pl. II). The grading was extended during the year to section 0 by hydraulic grader *No. 5*, which began operations January 3 and continued until stopped by high water, March 6, 1905. The material was stiff buckshot clay, unusually full of stumps, which made progress slow and increased the cost. A total of 2,700 linear feet of bank was graded, at an average cost of $1.43 per foot. The graded bank was paved with rock, underlaid with a 2-inch layer of coarse gravel, from section 21 to between sections I and H, 32,600 square feet, at an average cost of $0.1072 per square foot. Interruptions by the fluctuations of the river increased the cost to some extent.

Other operations at this locality consisted in repairs to about 2,000 linear feet of upper bank pavement at the lower end of the revetment, in digging ditches for drainage of borrow pits, and in clearing and felling timber, above and below the revetment, that might cave into the river and form obstructions to future work.

At the end of the working season the subaqueous revetment was continuous for a length of 10,311 feet, measured parallel to the general shore line. Of the upper bank there remains about 6,300 linear feet to be graded and paved to complete the work.

The annual hydrographic survey of the bend developed no unfavorable changes, except a recession of the 50-foot contour toward the bank between sections 1 and 11.

Details of the work and its cost are set forth in the appended reports of my assistants, Mr. H. S. Douglas and Mr. E. B. Geddes, and map is herewith (Pl. II) showing location of work.

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The amount expended from June 30, 1904, to June 30, 1905, is $81,657.91, distributed as follows:

Office expenses, main office		$3,205.67
Other administrative expenses		3,429.09
Construction (hired labor):		
Materials	$28,772.75	
Wages	29,016.40	
Subsistence	10,200.51	
		67,989.66
Surveys		983.24
Repairs to plant		1,038.73
Care of plant		4,050.54
New plant		930.50
Miscellaneous		30.48
Total		81,657.91

Money statement.

ALLOTMENT FOR KEMPE BEND REVETMENT.

July 1, 1904, balance unexpended		$3,005.20
Amount allotted from sundry civil act approved April 28, 1904		80,000.00
Amount allotted from river and harbor act approved March 3, 1905		90,000.00
		173,005.20
June 30, 1905, amount expended during fiscal year:		
For works of improvement	$81,052.11	
For maintenance of improvement	605.80	
		81,657.91
July 1, 1905, balance unexpended		91,347.29
July 1, 1905, outstanding liabilities		2,172.83
July 1, 1905, balance available		89,174.46
July 1, 1905, amount covered by uncompleted contracts		459.00
Amount (estimated) required for completion of existing project		Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905:		
For works of improvement	$60,000.00	
For maintenance of improvement	30,000.00	
		90,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

ABSTRACT OF APPROPRIATIONS.

By act of Congress of—	
March 3, 1899 (sundry civil act), allotted	$180,000
June 6, 1900 (sundry civil act), allotted	150,000
June 13, 1902 (river and harbor act), allotted	60,000
March 3, 1903 (sundry civil act), allotted	64,000
March 3, 1903 (sundry civil act) allotted by transfer	30,000
April 28, 1904 (sundry civil act), allotted	80,000
March 3, 1905 (river and harbor act), allotted	90,000
Total	654,000

HARBORS OF NATCHEZ AND VIDALIA.

For history of this work, project, and details of its execution, see current summary, and previous Annual Reports of the Chief of Engineers.

At the beginning of the year there was in place about 14,674 linear feet (14,571 corrected measurement) of revetment of various kinds, measured parallel to the general shore line, and the work was in fairly good condition.

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The project approved July 23, 1904, for application of $40,000, allotted from the emergency act of April 28, 1904, provided:

"(*a*) For the extension of the Upper Giles Bend revetment 450 feet upstream and 150 feet downstream to prevent threatened loss of work now in place;

"(*b*) For the extension of the Middle Giles Bend revetment about 300 feet upstream and 150 feet downstream to prevent threatened loss of all work now in place;

"(*c*) For the extension of the Lower Giles Bend revetment about 300 feet upstream to prevent flanking of work now in place; and

"(*d*) For miscellaneous repairs of the revetment in place."

Mattress construction for this work was begun August 12, 1904, and operations were carried on in connection with other works in the locality until January 12, 1905, when work was suspended.

All the work included in the above project was completed. The lower revetment was extended 351 feet upstream, giving this section a total length of 7,023 feet measured parallel to the general shore line. The middle revetment was extended 265 feet upstream and 115 feet downstream, making its total length 693 feet. The upper revetment was extended 485 feet upstream and 121 feet downstream, making its total length 8,192 feet, measured parallel to the general shore line. The total length of revetment added this season was 1,337 feet, and it was necessary for this purpose to revet 1,427 linear feet of bank with mattresses 300 feet wide, which required 399,565 square feet of mattress. Miscellaneous repairs were made at the shore ends of the spurs, and several breaks in the upper bank pavement were filled up and repaired.

During the year about 600 feet of bank near section 27 was graded and paved with rock to about a two-thirds stage. For repair work and for connecting the pavement near section 27 with the subaqueous revetment 61,235 square feet of mattress was required.

All of the mattresses required for this work, a total of 460,800 square feet, were constructed at Racehorse Island, 90 miles above, and towed to Giles Bend at an average cost of $0.0559 per square foot in place.

The annual survey of Giles Bend, made between September 17 and November 25, 1904, shows the existing work generally in good condition, but there has been some scour in the upper end of the bend, and the recession of the bank line over the unprotected portion of the bend has continued at the rate of about 100 feet a year. There has also been a deepening of the channel at the outer edge of the mattress work.

The details of the work and its cost are set forth in the appended reports of my assistants, Mr. H. S. Douglas and Mr. E. B. Geddes. Map is herewith (Pl. III), showing the work done this and previous years, and the unprotected parts of Giles Bend between the upper and middle and the middle and lower sections of revetment. For general map of Giles Bend see Annual Report of the Chief of Engineers for 1904, Plate II, opposite page 298, Supplement.

The amount expended from June 30, 1904, to June 30, 1905, is $40,000, distributed as follows:

Office expenses, main office		$2,360.86
Other administrative expenses		1,632.65
Construction (hired labor):		
Materials	$13,703.28	
Wages	15,641.88	
Subsistence	4,094.52	
		33,439.68
Surveys		1,066.37
Repairs to plant		461.44
Care of plant		630.67
New plant		386.31
Miscellaneous		22.02
Total		40,000.00

Money statement.

EMERGENCIES IN RIVER AND HARBOR WORKS, ALLOTMENT FOR MISSISSIPPI RIVER AT GILES BEND.

Amount allotted from appropriation for emergencies in river and harbor works, act of April 28, 1904	$40,000.00

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June 30, 1905, amount expended during fiscal year:		
For works of improvement	$38,171.73	
For maintenance of improvement	1,828.27	
		$40,000.00

The amount expended from June 30, 1904, to June 30, 1905, is $650.36, distributed as follows:

Office expenses, main office		$125.00
Other administrative expenses		23.75
Construction (hired labor):		
Materials	$145.00	
Wages	9.00	
		154.00
Repairs to plant		173.80
Care of plant		173.81
Total		650.36

Money statement.

ALLOTMENT FOR HARBORS AT NATCHEZ AND VIDALIA, MISS. AND LA.

July 1, 1904, balance unexpended	$650.36
Amount allotted from sundry civil act approved March 3, 1905	40,000.00
	40,650.36
June 30, 1905, amount expended during fiscal year, for maintenance of improvement	650.36
July 1, 1905, balance unexpended	40,000.00
July 1, 1905, outstanding liabilities	1,013.17
July 1, 1905, balance available	38,986.83
July 1, 1905, amount covered by uncompleted contracts	5,197.50
Amount (estimated) required for completion of existing project	Indeterminate.

Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905:		
For works of improvement	$200,000.00	
For maintenance of improvement	10,000.00	
		210,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

ABSTRACT OF APPROPRIATIONS.[a]

By act of Congress of—	
June 14, 1880 (river and harbor act)	$40,000
March 3, 1881 (river and harbor act)	50,000
July 13, 1892 (river and harbor act)	80,000
August 17, 1894 (sundry civil act)	80,000
June 3, 1896 (river and harbor act), allotted	64,000
June 3, 1896 (river and harbor act), allotted by transfer	25,000
June 4, 1897 (river and harbor act), allotted	[b] 85,000
March 3, 1899 (sundry civil act)	50,000
June 6, 1900 (sundry civil act), allotted	150,000
June 13, 1902 (river and harbor act), allotted	60,000
March 3, 1903 (sundry civil act), allotted	12,000
March 3, 1905 (sundry civil act), allotted	40,000
Total	[c] 736,000

[a] This includes allotments for "Giles Bend."

[b] Original allotment, $125,000, out of which $40,000 was transferred to "New Orleans Harbor," by authority Secretary of War, June 27, 1898.

[c] $81,747.96 expended before the Mississippi River Commission assumed charge of this work.

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IMPROVING ATCHAFALAYA AND RED RIVERS, LOUISIANA.

For history of this work, project, and details of its execution, see current summary, and previous Annual Reports of the Chief of Engineers.

On August 24, 1904, parties interested in the navigation of Old River reported a depth of only 7½ feet in the channel over the bar at the mouth, the Barbres gauge on this date reading 11.2 feet. The hydraulic dredge *The Ram*, belonging to this work, was put in commission, and left the engineer depot at New Orleans on September 1, arriving at the mouth of Old River on September 5, 1904.

Examination showed a greater depth in the channel than was reported, but dredging was necessary, and *The Ram* commenced operations on September 7 and continued at work until October 4, 1904. In twenty working days the dredge removed an estimated quantity of 80,000 cubic yards of material, making a channel with a depth of about 6 feet below the zero of Barbres gauge and a width of about 100 feet for a distance of about 2,100 feet over the bar. Cross currents at the Mississippi end of the dredged cut caused some shoaling, but at no time was navigation obstructed, although the Barbres gauge fell to 0.3 foot.

After completion of the dredging *The Ram* was kept in the vicinity, either laid up or at work as a towboat. No further dredging was necessary, however, and she returned to the engineer depot about the end of January, 1905.

The hydrographic survey of lower Old River, referred to in report on surveys, developed but slight changes in average cross section from 1894 to date, the average increase in mean depth being 0.5 foot and average increase in mean section being 128 square feet. The comparative sections have been carefully computed, those for the years 1894, 1903, and 1905 being published in Appendix C of this report.

The survey over the bar at the Mississippi end of Old River shows that the distance between the 5-foot contours is becoming greater, which increases the amount of dredging required to maintain navigation.

The survey over the sill dams in the Atchafalaya shows that scour has taken place in their vicinity, as compared with the survey of February, 1903, but it is not believed that this scour is of serious importance. The sills themselves are in good condition, except the shore end of sill Dam No. 3 mentioned in the last annual report. This has not been repaired, owing to lack of funds.

Additional details of this work will be found in the appended report of my assistant, Mr. H. S. Douglas. Sketch is herewith (Pl. IV), showing dredged channel at mouth of Old River.

The amount expended from June 30, 1904, to June 30, 1905, is $3,008.86, distributed as follows:

Office expense, main office		$323.64
Other administrative expenses		32.95
Construction (hired labor):		
Materials	$564.48	
Wages	903.50	
Subsistence	492.62	
		1,960.60
Surveys		43.48
Repairs to plant		226.94
Care of plant		175.98
New plant		242.27
Miscellaneous		3.00
Total		3,008.86

Money statement.

ALLOTMENT FOR ATCHALAFAYA AND RED RIVERS, LOUISIANA.

July 1, 1904, balance unexpended	$2,008.86
Amount allotted from sundry civil act approved April 28, 1904	1,000.00
Amount allotted from sundry civil act approved March 3, 1905	24,000.00
	27,008.86
June 30, 1905, amount expended during fiscal year, for maintenance of improvement	3,008.86

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July 1, 1905, balance unexpended	$24,000.00
July 1, 1905, outstanding liabilities	67.70
	23,932.30
Amount (estimated) required for completion of existing project	Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1907, for maintenance of improvement, in addition to the balance unexpended July 1, 1905. Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	50,000.00

ABSTRACT OF APPROPRIATIONS.

By act of Congress of—	
June 18, 1878 (river and harbor act)	$150,000
March 3, 1879 (sundry civil act)	40,000
January 19, 1884 (river and harbor act), allotted by transfer	1,400
July 5, 1884 (river and harbor act), allotted	12,290
July 5, 1884 (river and harbor act), allotted by transfer	10,500
July 5, 1884 (river and harbor act), allotted	15,000
August 5, 1886 (river and harbor act), allotted	187,500
August 11, 1888 (river and harbor act), allotted	250,000
September 19, 1890 (river and harbor act), allotted	[a] 217,000
September 19, 1890 (river and harbor act), allotted by transfer	3,000
July 13, 1892 (river and harbor act), allotted	80,000
August 18, 1894 (sundry civil act), allotted	[b] 70,000
June 3, 1896 (river and harbor act), allotted	40,000
March 3, 1899 (sundry civil act), allotted	25,000
June 13, 1902 (river and harbor act), allotted	15,000
June 13, 1902 (river and harbor act), allotted	1,000
March 3, 1905 (sundry civil act), allotted	24,000
Total	1,141,690

NEW ORLEANS HARBOR.

For history of this work, project, and details of its execution see current summary, page —, and previous Annual Reports of the Chief of Engineers.

No construction work was done during the year, no funds having been appropriated or allotted.

Operations were confined to the annual surveys called for by resolution of the Commission and to examinations and inspections of the localities where work has been done.

The surveys show that very little change has taken place in Carrollton Bend; that between old spurs Nos. 1 to 6, Gouldsboro Bend, which have been in place from seventeen to twenty-one years, there has been a gradual recession of the 90-foot contour until the maximum slope of bank from 0 to 90 foot contours varies from 1 on 1.4 to 1 on 1.9. It is therefore apparent that additional spurs will be needed between existing spurs. In the third district reach there has been extensive failure of the skeleton wharf bank protection placed by the local authorities in 1896–97. General map is herewith, showing location of works of improvement (Pl. V).

The amount expended from June 30, 1904, to June 30, 1905, is $1,109.21, distributed as follows:

Office expenses, main office	$214.00
Other administrative expenses	529.29
Construction (hired labor), materials	296.40
Surveys	69.52
Total	1,109.21

[a] Original allotment, $225,000; $8,000 transferred to "New Orleans Harbor."
[b] $2,500 expended improving Bayou des Glaises.

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Money statement.

ALLOTMENT FOR NEW ORLEANS HARBOR, LOUISIANA.

July 1, 1904, balance unexpended	$6,164.33
Amount allotted from sundry civil act, approved March 3, 1905	85,000.00
	91,164.33
June 30, 1905, amount expended during fiscal year, for maintenance of improvement	1,109.21
July 1, 1905, balance unexpended	90,055.12
July 1, 1905, outstanding liabilities	2,526.84
July 1, 1905, balance available	87,528.28
July 1, 1905, amount covered by uncompleted contracts	9,922.00
Amount (estimated) required for completion of existing project	Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905:	
For works of improvement $300,000.00	
For maintenance of improvement 10,000.00	
	310,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

ABSTRACT OF APPROPRIATIONS.

By act of Congress of—	
June 18, 1878 (river and harbor act)	$50,000.00
March 3, 1879 (sundry civil act)	60,000.00
June 14, 1880 (sundry civil act)	75,000.00
March 3, 1881 (river and harbor act)	75,000.00
August 2, 1882 (river and harbor act), allotted	4,500.00
July 5, 1884 (river and harbor act), allotted	6,462.86
August 5, 1886 (river and harbor act)	75,000.00
August 11, 1888 (river and harbor act)	[a] 199,888.00
September 19, 1890 (river and harbor act)	100,000.00
September 19, 1890 (river and harbor act), allotted by transfer	8,000.00
July 13, 1892 (river and harbor act)	80,000.00
August 18, 1894 (sundry civil act)	110,000.00
June 3, 1896 (river and harbor act)	110,000.00
June 4, 1897 (river and harbor act), allotted by transfer	10,000.00
June 4, 1897 (river and harbor act), allotted by transfer	40,000.00
March 3, 1899 (sundry civil act)	110,000.00
June 13, 1902 (river and harbor act)	95,000.00
March 3, 1905 (sundry civil act)	85,000.00
Received from various sources	[b] 18.39
Total	1,293,869.25

PLANT.

At the date of last report the plant of the district consisted of 47 large pieces. During the year 11 new standard barges of creosoted lumber have been completed and delivered under contract; new hull for quarter boat *New Orleans*, of creosoted lumber, was completed and delivered under contract; four barges became unserviceable and were condemned and sold. The plant now consists of 54 large pieces.

The new steel-hull stern-wheel steamboat *Tensas*, referred to in last annual report, was completed by the contractors in October, 1904, but was caught in the ice near Portage, Wis., while en route to New Orleans and was not delivered until May 29, 1905.

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[a] Original appropriation $200,000; $112 reserved by Chief of Engineers for office expenses.

[b] Disallowance, January 29, 1890, $0.04; reimbursement, March 19, 1892, by Captain Kingman, $1; deposit, May 12, 1892, funds not called for by employees, $9.35; disallowances, July 1, 1894, $8; total, $18.39.

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The plant when not in use in the field was cared for, maintained, and repaired at the engineer depot at New Orleans, and, with the exception of eight barges, is now in good condition. These eight barges are almost beyond economical repair. A detailed statement of the work done for the care and maintenance of the plant is given in the appended report of Assistant Engineer H. S. Douglas

The amount expended from June 30, 1904, to June 30, 1905, is $80,363.35, distributed as follows:

Office expenses, main office		$2,114.88
Other administrative expenses		3,204.57
Construction (hired labor):		
Materials	$8,150.33	
Wages	9,441.87	
Subsistence	374.88	
		17,967.08
Care of plant		3,852.74
New plant		53,224.08
Total		80,363.35

Money statement.

ALLOTMENT FOR PLANT.

July 1, 1904, balance unexpended		$44,956.15
Amount allotted from sundry civil act approved April 28, 1904		38,000.00
Amount allotted from sundry civil act approved March 3, 1905		45,000.00
Amount received from proceeds of sale, condemned engineer property		1,018.80
		128,974.95
June 30, 1905, amount expended during fiscal year:		
For works of improvement	$52,969.83	
For maintenance of improvement	27,393.52	
		80,363.35
July 1, 1905, balance unexpended		48,611.60
July 1, 1905, outstanding liabilities		2,524.89
July 1, 1905, balance available		46,086.71
July 1, 1905, amount covered by uncompleted contracts		556.00
Amount (estimated) required for completion of existing project		Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905:		
For works of improvement	$25,000.00	
For maintenance of improvement	25,000.00	
		50,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

ABSTRACT OF APPROPRIATIONS.

By act of Congress of—	
August 18, 1894 (sundry civil act)	$10,000.00
June 4, 1897 (river and harbor act)	20,000.00
Transferred from quartermaster's department, authority Secretary of War, September 21, 1898	8,000.00
By act of Congress of—	
July 1, 1898 (sundry civil act), allotted	5,556.00
March 3, 1899 (sundry civil act), allotted	64,444.00
June 6, 1900 (sundry civil act), allotted	25,000.00
June 13, 1902 (river and harbor act), allotted	111,000.00
March 3, 1903 (sundry civil act), allotted	47,000.00
By proceeds of sale of engineer property	6,911.35
Received for injuries to barge	18.00
By act of Congress of—	
April 28, 1904 (sundry civil act), allotted	38,000.00
March 3, 1905 (sundry civil act), allotted	45,000.00
Total	380,929.35

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SURVEYS, GAUGES, AND OBSERVATIONS.

During the year the annual surveys called for by resolution of the Mississippi River Commission were made at Giles Bend, Kempe Bend, Old River, sill dams in Atchafalaya River and in New Orleans Harbor, at Carrollton, Gretna, Gouldsboro, and Algiers bends, and the third district reach. Of these surveys only those in Old River, at sill dams in Atchafalaya River, and in New Orleans Harbor were charged to the allotment for surveys; the cost of the others was charged to the works in progress.

The gauge at Barbres Landing, at the junction of the Red and Atchafalaya rivers, was maintained as heretofore.

The conditions developed by the surveys were referred to in the reports on the works at the various localities.

The amount expended from June 30, 1904, to June 30, 1905, is $5,593.97, distributed as follows:

Office expenses, main office		$157.50
Other administrative expenses		15.85
Field work and drafting:		
Materials	$597.27	
Wages	3,984.74	
Subsistence	536.49	
		5,118.50
Repairs to plant		107.08
Care of plant		56.34
New plant		8.70
Maintenance of gauge at Barbres, La.		130.00
Total		5,593.97

Money statement.

SURVEYS, FOURTH DISTRICT.

July 1, 1904, balance unexpended	$1,081.03
Amount allotted from sundry civil act approved April 28, 1904	5,000.00
Amount allotted from sundry civil act approved March 3, 1905	5,000.00
	11,081.03
June 30, 1905, amount expended during fiscal year, for maintenance of improvement	5,593.97
July 1, 1905, balance unexpended	5,487.06
July 1, 1905, outstanding liabilities	148.00
July 1, 1905, balance available	5,339.06
Amount (estimated) required for completion of existing project	Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1907, for maintenance of improvement, in addition to the balance unexpended July 1, 1905. Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	7,000.00

ABSTRACT OF APPROPRIATIONS.

By act of Congress of—

August 11, 1886 (river and harbor act), allotted	$9,000
August 11, 1886 (river and harbor act), allotted	2,000
August 11, 1888 (river and harbor act), allotted	1,000
August 11, 1888 (river and harbor act), allotted	3,000
September 19, 1890 (river and harbor act), allotted	12,000
September 19, 1890 (river and harbor act), allotted by transfer	1,000
July 13, 1892 (river and harbor act), allotted	12,000
March 2, 1893 (sundry civil act), allotted	12,000

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By act of Congress of—Continued.	
August 17, 1894 (sundry civil act), allotted	$12,000
March 3, 1895 (sundry civil act), allotted	10,000
June 3, 1896 (river and harbor act), allotted	500
March 3, 1899 (sundry civil act), allotted	5,000
June 6, 1900 (sundry civil act), allotted	6,000
June 13, 1902 (river and harbor act), allotted	5,000
March 3, 1903 (sundry civil act), allotted	6,000
April 28, 1904 (sundry civil act), allotted	5,000
March 3, 1905 (sundry civil act), allotted	5,000
Total	106,500

LEVEES.

For work of levee construction and maintenance, the fourth district, improving Mississippi River, is subdivided into seven levee districts. (For limits of the districts see current summary, also Pls. VI, VII, and VIII, herewith.)

The only levee work done by the United States in the Lower Tensas levee district during the year was the completion of sections 4 and 5, White Oak Lake, Lot 2, levee, a total of 25,591.76 cubic yards, at 24.74 cents per cubic yard. By resolution of the Mississippi River Commission, the expenditure of the allotment for levees for year 1905 was deferred pending developments in Kempe Bend.

By Commission resolution of April 12, 1905, it was directed that a project be prepared for the extension of the Bougere levee. A survey for this purpose was begun on April 21, 1905, and was completed May 19, 1905.

The work done by the United States during the year in the Atchafalaya, Lafourche, Barataria, Pontchartrain, and Lake Borgne levee districts is given in detail in tabular form later in this report. No work was done in the Homochitto levee district, no funds being available.

On July 1, 1904, the amount of levee work required to complete the contracts then in force was 677,493 cubic yards, at an average cost of 16.93 cents per cubic yard. Since July 1, 1904, contracts have been made for 1,316,481.25 cubic yards of levee work, at an average cost of 14.33 cents. This reduced cost is accounted for by the fact that in the Lafourche and Pontchartrain levee districts the greater amount of levee work is now done by steam excavating machines instead of by mules and scrapers as formerly.

Following the custom of previous years, the tables and statements as to levee construction herewith are for the period May 1, 1904, to May 1, 1905. During this period the total amount of levee work completed by the United States was 1,711,964.25 cubic yards, at an average cost of 15.38 cents per cubic yard. This includes 357,467.84 cubic yards of work done in the Pontchartrain levee district under authority of act of Congress of April 28, 1904, to be paid for when the appropriation for the fiscal year 1906 becomes available.

During the year a survey was made of the levee system in the Barataria and Lake Borgne districts, which included topography, levels, and establishment of bench marks for future levee work.

Since the date of last report the river has not reached a stage which rendered necessary any protective measures against high water. For the maintenance of the levees weeds were cut at a great many localities during the year.

On April 26, 1905, the Assistant Secretary of War approved the allotments for levee work made by the Commission at its last session from the appropriation contained in river and harbor act of March 3, 1905. Projects for the expenditure of these allotments, and also for the allotments made from the sundry civil act of March 3, 1905 (except in the Lower Tensas levee district), have been submitted.

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The following table shows approximately the present condition of the levee lines in the fourth district as to grade:

	Levee districts.					
	Lower Tensas.[a]	Atchafalaya.	Lafourche.[b]	Pontchartrain.[c]	Barataria.[d]	Lake Borgne.[d]
Above high water of 1897:	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*
Less than 1 foot	.....	.....	0.51	1.86	10.96	7.5
From 1 to 2 feet	.....	.....	6.83	14.06	29.88	33.9
From 2 to 3 feet	30.15	2.29	13.89	8.34	.....	.....
From 3 to 4 feet	75.35	20.38	4.27	18.54	.....	.....
Up to grade	37.26	105.79	56.66	82.84	31.04	35.8
Total	142.76	128.46	82.16	125.64	71.88	77.2

[a] 15.84 miles, included in the 75.35 miles of levee 3 to 4 feet above highest water, are 4 feet or more above highest water, but below grade.
[b] The grade in this district varies from 2.9 to 4.2 feet above the highest water. The length given from 3 to 4 feet is below grade.
[c] The grade in this district is from 3.4 to 4.6 feet above the 1897 high water. Levees from 3 to 4 feet above highest water are those that are not up to grade.
[d] Highest water 1908.

For further details of levee work attention is invited to the tables and to the accompanying report of my assistant, Mr. W. E. Knobloch, superintendent of levees.

Fourth district levees, 1904–5.

LOWER TENSAS LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	White Oak Lake:				*Feet.*	*Feet.*	*Feet.*
1	Section 4	631	R.	Bobbitt & Linnan	800	715	19.6
2	Section 5	631	R.	....do	800	700	19.6

No.	Name of levee.	Date of contract.	Work completed.	Total yardage paid for.	Price per cubic yard.	Total cost.	Grade of levee above highest known water.
	White Oak Lake:				*Cents.*		*Feet.*
1	Section 4	July 1, 1903	July 24, 1904	12,617.80	24.74	$3,121.64	5
2	Section 5	....do	....do	12,973.96	24.74	3,209.76	5

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Distance from center of levee to river bank.			Nature of bank.
		Crown.	Land slope.	River slope.			Least.	Greatest.	Average.	
	White Oak Lake:	*Feet.*	*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	Section 4	8	3 to 1	3 to 1	Enlargt..	2.6	7,100	7,420	7,290	Caving.
2	Section 5	8	3 to 1	3 to 1	....do....	2.4	6,700	7,100	6,890	Do.

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Fourth district levees, 1904–5—Continued.

ATCHAFALAYA LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	Red River Landing:				*Feet.*	*Feet.*	*Feet.*
1	Section 2	766	R.	James R. Marlow	1,000	1,000	17.0
2	Section 3	766	R.	do	1,000	1,000	17.0
3	Section 5	766	R.	do	1,100	1,100	18.0
4	Section 6	766	R.	do	700	700	19.5
	Henriette:						
5	Section 1	768	R.	C. H. Whipple	1,800	1,600	13.0
6	Section 2	768	R.	do	1,600	2,000	12.3
7	Section 3	768	R.	do	1,400	1,800	12.3
8	Section 4	768	R.	do	1,500	1,900	12.0
9	Section 5	768	R.	do	1,300	1,700	12.0
10	Section 6	768	R.	do	1,700	2,100	11.8
	Latenache:						
11	Section 1	770	R.	do	2,000	2,400	12.0
12	Section 2	770	R.	do	2,200	2,600	11.2
13	Section 3	770	R.	do	2,200	2,600	10.5
	New Texas:						
14	Section 1	786	R.	M. L. Linnan	1,375	1,800	19.5
15	Section 2	786	R.	do	1,400	1,890	16.5
16	Section 3	786	R.	do	900	890	16.8
17	Section 4	786	R.	do	900	900	17.3
18	Section 5	786	R.	do	1,200	1,200	16.0
19	Section 6	786	R.	do	1,600	1,600	16.2
20	Section 7	786	R.	do	1,300	1,300	17.5
21	Section 8	786	R.	do	1,498	1,500	18.5
	Upper Morganza:						
22	Section 1	788	R.	James R. Marlow	1,555	1,900	18.5
23	Section 2	788	R.	do	1,700	350	18.5
24	Section 4	788	R.	do	1,281	1,350	21.5
	Point Coupee:						
25	Section 1	797	R.	do	2,550	1,320	16.0

No.	Name of levee.	Date of contract.	Work completed.	Total yardage paid for.	Price per cubic yard.	Total cost.	Grade of levee above highest known water.
	Red River Landing:				*Cents.*		*Feet.*
1	Section 2	Dec. 11, 1902	July 4, 1904	13,311.27	19.25	$2,562.42	4.2
2	Section 3	do	June 27, 1904	13,306.99	19.25	2,561.41	4.2
3	Section 5	do	Sept. 19, 1904	12,769.41	19.25	2,458.11	4.2
4	Section 6	do	do	11,441.88	19.25	2,202.55	4.2
	Henriette:						
5	Section 1	Apr. 1, 1904	Oct. 6, 1904	12,383.69	19.50	2,414.82	3.9
6	Section 2	do	Nov. 29, 1904	12,515.98	19.50	2,440.60	3.6
7	Section 3	do	do	12,688.54	19.50	2,473.29	3.4
8	Section 4	do	Sept. 10, 1904	13,029.30	19.50	2,540.71	3.4
9	Section 5	do	Sept. 20, 1904	12,500.61	19.50	2,437.62	3.5
10	Section 6	do	Nov. 8, 1904	12,496.87	19.50	2,436.89	3.7
	Latenache:						
11	Section 1	do	Oct. 10, 1904	13,268.78	15.50	2,056.66	4.3
12	Section 2	do	June 9, 1904	13,361.48	15.50	2,071.02	4.3
13	Section 3	do	June 29, 1904	13,695.24	15.50	2,122.76	4.3
	New Texas:						
14	Section 1	Feb. 21, 1904	Aug. 29, 1904	12,032.42	21.74	2,615.85	4.3
15	Section 2	do	do	12,220.89	21.74	2,656.82	4.2
16	Section 3	do	Sept. 17, 1904	12,221.90	21.74	2,657.04	4.2
17	Section 4	do	do	12,848.42	21.74	2,793.24	4.2
18	Section 5	do	Oct. 6, 1904	12,047.89	21.74	2,619.21	4.2
19	Section 6	do	Oct. 7, 1904	11,602.20	21.74	2,522.32	4.1
20	Section 7	do	Oct. 17, 1904	11,212.05	21.74	2,437.50	4.1
21	Section 8	do	Oct. 19, 1904	12,253.37	21.74	2,663.88	4.0
	Upper Morganza:						
22	Section 1	Nov. 8, 1904	Mar. 6, 1905	13,581.34	21.97	2,998.26	4.1
23	Section 2	do	Jan. 22, 1905	13,808.41	21.97	3,033.71	4.0
24	Section 4	do	Jan. 10, 1905	12,866.48	21.97	2,826.76	4.1
	Point Coupee:						
25	Section 1	do	Apr. 14, 1905	14,759.08	19.90	2,937.06	4.1

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Fourth district levees, 1904–5—Continued.

ATCHAFALAYA LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Distance from center of levee to river bank.			Nature of bank.
		Crown.	Land slope.	River slope.			Least.	Greatest.	Average.	
	Red River Landing:	*Feet.*	*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	Section 2 ..	8	3 to 1	3 to 1	Enlargement.	1.6	1,080	1,100	1,070	Caving.
2	Section 3 ..	8	3 to 1	3 to 1	....do	1.7	1,060	1,120	1,090	Do.
3	Section 5 ..	8	3 to 1	3 to 1	....do	1.8	1,100	1,320	1,200	Do.
4	Section 6 ..	8	3 to 1	3 to 1	....do	2.0	1,310	1,370	1,320	Do.
	Henriette:									
5	Section 1 ..	8	3 to 1	3 to 1	....do	1.8	43,000	43,500	43,250	Stationary.
6	Section 2 ..	8	3 to 1	3 to 1	....do	1.2	43,000	43,500	43,250	Do.
7	Section 3 ..	8	3 to 1	3 to 1	....do	1.0	43,000	43,500	43,250	Do.
8	Section 4 ..	8	3 to 1	3 to 1	....do	1.2	45,000	46,000	45,500	Do.
9	Section 5 ..	8	3 to 1	3 to 1	....do	1.0	45,000	46,000	45,500	Do.
10	Section 6 ..	8	3 to 1	3 to 1	....do	1.0	45,000	46,000	45,500	Do.
	Latenache:									
11	Section 1 ..	8	3 to 1	3 to 1	....do	1.0	45,000	46,000	45,500	Do.
12	Section 2 ..	8	3 to 1	3 to 1	....do	1.2	45,000	46,000	45,500	Do.
13	Section 3 ..	8	3 to 1	3 to 1	....do	1.0	45,000	46,000	45,000	Do.
	New Texas:									
14	Section 1 ..	8	3 to 1	3 to 1	....do	1.3	570	615	600	Caving.
15	Section 2 ..	8	3 to 1	3 to 1	....do	1.5	570	640	620	Do.
16	Section 3 ..	8	3 to 1	3 to 1	....do	1.7	360	440	370	Do.
17	Section 4 ..	8	3 to 1	3 to 1	....do	2.0	360	440	400	Do.
18	Section 5 ..	8	3 to 1	3 to 1	....do	1.6	350	1,400	1,000	Do.
19	Section 6 ..	8	3 to 1	3 to 1	....do	.8	1,420	1,650	1,450	Do.
20	Section 7 ..	8	3 to 1	3 to 1	....do	1.0	1,420	1,650	1,440	Do.
21	Section 8 ..	8	3 to 1	3 to 1	....do	1.8	1,570	1,800	1,700	Do.
	Upper Morganza:									
22	Section 1 ..	8	3 to 1	3 to 1	....do	2.3	1,200	1,300	1,250	Do.
23	Section 2 ..	8	3 to 1	3 to 1	....do	2.1	1,300	2,000	1,650	Do.
24	Section 4 ..	8	3 to 1	3 to 1	....do	2.2	2,300	2,600	2,450	Do.
	Point Coupee:									
25	Section 1 ..	8	3 to 1	3 to 1	....do	.8	1,450	2,450	1,950	Do.

[Uncompleted levees.]

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	Upper Morganza:				*Feet.*	*Feet.*	*Feet.*
1	Section 3	788	R.	Jas. R. Marlow	1,200	650	19.6
	Point Coupee:						
2	Section 2	797	R.	.....do	1,524	1,320	17.0

No.	Name of levee.	Date of contract.	Total yardage.	Price per cubic yard.	Distance from center of levee to river bank.			Grade of levee above highest known water.
					Least.	Greatest.	Average.	
	Upper Morganza:			*Cents.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	Section 3.....	Nov. 8, 1904	13,853.06	21.97	2,000	2,300	2,150	4.1
	Point Coupee:							
2	Section 2.....	.....do	11,980.84	19.90	1,450	2,450	1,950	4.0

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Nature of bank.	Condition of contract.
		Crown.	Land slope.	River slope.				
	Upper Morganza:					*Feet.*		
1	Section 3.....	8	4 to 1	4 to 1	Enlargement.	2.1	Caving	42 per cent in place.
	Point Coupee:							
2	Section 2.....	8	3 to 1	3 to 1	...do	1.0	.....do	Nothing done.

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Fourth district levees, 1904–5—Continued.

LAFOURCHE LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	St. James.				*Feet.*	*Feet.*	*Feet.*
1	Section 4	904.5	R.	Menzies & Co.	1,100	990	16.1
2	Section 5	904.5	R.	.....do	1,200	1,080	13.6
3	Section 6	904.5	R.	.....do	1,450	1,300	11.7
	Chopin:						
4	Section 1	906.0	R.	.....do	1,564	1,500	14.1
5	Section 2	906.0	R.	.....do	1,644	1,690	15.2
	Felicity:						
6	Section 1	909.0	R.	.....do	1,423	1,430	12.6
7	Section 2	909.0	R.	.....do	1,800	1,635	13.0
8	Section 3	909.0	R.	.....do	1,900	2,400	12.7
9	Section 4	909.0	R.	.....do	2,500	2,450	11.3
10	Section 5	909.0	R.	.....do	2,000	1,985	12.9
	Armant:						
11	Section 1	910.0	R.	.....do	2,300	2,000	11.3
12	Section 2	910.0	R.	.....do	2,300	2,100	10.8
13	Section 3	910.0	R.	.....do	1,900	1,700	10.4
14	Section 4	910.0	R.	.....do	1,900	1,745	11.0
15	Section 5	910.0	R.	.....do	2,421	2,420	9.8
	Gold Mine:						
16	Section 1	925.0	R.	Hearin & Ryan	1,956	1,708	9.1
17	Section 7	925.0	R.	.....do	2,100	2,650	12.8
18	Luling	940.0	R.	R. T. Clark	2,860	2,672	13.4
19	Lone Star	941.0	R.	.....do	8,233	8,208	13.2
20	Davis	942.0	R.	.....do	2,711	2,720	13.8

No.	Name of levee.	Date of contract.	Work completed.	Total yardage paid for.	Price per cubic yard.	Total cost.	Grade of levee above highest known water.
	St. James:				*Cents.*		*Feet.*
1	Section 4	Dec. 8, 1902	Nov. 12, 1904	7,311.62	14.50	$1,182.68	3.9
2	Section 5	.....do	June 18, 1904	5,985.11	14.50	867.84	3.9
3	Section 6	.....do	.....do	13,554.65	14.50	1,965.43	3.9
	Chopin:						
4	Section 1	.....do	Dec. 28, 1904	12,671.87	14.50	1,837.42	3.9
5	Section 2	.....do	Dec. 8, 1904	12,508.88	14.50	1,813.79	3.9
	Felicity:						
6	Section 1	June 29, 1904	Aug. 30, 1904	12,368.87	12.00	1,484.27	3.9
7	Section 2	.....do	Aug. 31, 1904	12,660.20	12.00	1,519.22	3.7
8	Section 3	.....do	.....do	12,763.43	12.00	1,531.61	3.7
9	Section 4	.....do	Sept. 26, 1904	12,537.81	12.00	1,504.54	3.8
10	Section 5	.....do	.....do	12,916.10	12.00	1,549.93	3.8
	Armant:						
11	Section 1	.....do	Oct. 7, 1904	12,468.38	12.00	1,496.21	3.8
12	Section 2	.....do	Oct. 8, 1904	12,708.77	12.00	1,525.05	3.7
13	Section 3	.....do	Nov. 3, 1904	12,499.57	12.00	1,499.94	3.7
14	Section 4	.....do	.....do	12,795.75	12.00	1,535.49	3.7
15	Section 5	.....do	.....do	12,557.04	12.00	1,506.84	3.7
	Gold Mine:						
16	Section 1	Dec. 19, 1904	Mar. 29, 1905	9,314.09	11.97	1,114.90	3.6
17	Section 7	.....do	Apr. 24, 1905	12,382.28	11.97	1,536.02	3.5
18	Luling	June 29, 1904	Mar. 10, 1905	14,087.15	16.97	2,390.59	3.4
19	Lone Star	.....do	Oct. 18, 1904	14,160.86	16.97	2,403.10	3.4
20	Davis	.....do	Feb. 13, 1905	13,731.53	16.97	2,330.24	3.4

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Fourth district levees, 1904–5—Continued.

LAFOURCHE LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Distance from center of levee to river bank.			Nature of bank.
		Crown.	Land slope.	River slope.			Least.	Greatest.	Average.	
	St. James:	*Ft.*	*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	Section 4	8	3 to 1	3 to 1	Enlargement.	2.4	270	380	330	Washing.
2	Section 5	8	3 to 1	3 to 1	....do	2.2	290	365	325	Do.
3	Section 6	8	3 to 1	3 to 1	....do	2.1	165	390	260	Do.
	Chopin:									
4	Section 1	8	3 to 1	3 to 1	....do	2.0	600	730	660	Do.
5	Section 2	8	3 to 1	3 to 1	....do	1.8	570	765	595	Do.
	Felicity:									
6	Section 1	8	3 to 1	3 to 1	....do	1.8	360	575	450	Stationary.
7	Section 2	8	3 to 1	3 to 1	....do	1.2	550	700	625	Making.
8	Section 3	8	3 to 1	3 to 1	....do	1.0	620	775	654	Do.
9	Section 4	8	3 to 1	3 to 1	....do	.7	600	775	675	Do.
10	Section 5	8	3 to 1	3 to 1	....do	1.4	520	700	590	Do.
	Armant:									
11	Section 1	8	3 to 1	3 to 1	....do	1.1	420	800	632	Do.
12	Section 2	8	3 to 1	3 to 1	....do	1.1	220	439	332	Stationary.
13	Section 3	8	3 to 1	3 to 1	....do	1.3	150	200	173	Washing.
14	Section 4	8	3 to 1	3 to 1	....do	1.9	113	305	183	Do.
15	Section 5	8	3 to 1	3 to 1	....do	1.5	178	296	254	Do.
	Gold Mine:									
16	Section 1	8	3 to 1	3 to 1	....do	1.4	104	200	158	Do.
17	Section 7	8	3 to 1	3 to 1	....do	1.1	304	500	482	Do.
18	Luling	8	3 to 1	3 to 1	....do	1.1	165	430	400	Do.
19	Lone Star	8	3 to 1	3 to 1	....do	1.1	165	364	275	Do.
20	Davis	8	3 to 1	3 to 1	....do	1.2	240	400	350	Do.

[Uncompleted levees.]

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	Gold Mine:				*Feet.*	*Feet.*	*Feet.*
1	Section 2	925	R.	Hearin & Ryan	1,041	1,041	12.7
2	Section 3	925	R.	.....do	2,097	2,098	10.6
3	Section 4	925	R.	.....do	2,000	1,995	11.6
4	Section 5	925	R.	.....do	2,500	2,790	11.0
5	Section 6	925	R.	.....do	2,300	2,140	11.1

No.	Name of levee.	Date of contract.	Total yardage.	Price per cubic yard.	Distance from center of levee to river bank.			Grade of levee above highest known water.
					Least.	Greatest.	Average.	
	Gold Mine:			*Cents.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	Section 2	Dec. 19, 1904	16,574.66	11.97	141	282	204	3.6
2	Section 3	.....do	11,315.24	11.97	210	325	300	3.6
3	Section 4	.....do	12,514.99	11.97	235	300	260	3.6
4	Section 5	.....do	12,887.88	11.97	243	452	404	3.5
5	Section 6	.....do	12,534.08	11.97	420	580	500	3.5

No.	Name of levee.	Section.			New or enlargement.	Average above old levee.	Nature of bank.	Condition of contract.
		Crown.	Land slope.	River slope.				
	Gold Mine:	*Ft.*	*Feet.*	*Feet.*		*Feet.*		
1	Section 2	8	3 to 1	3 to 1	New		Washing	No work done.
2	Section 3	8	3 to 1	3 to 1	Enlargement.	1.3	.....do	46 per cent in place.
3	Section 4	8	3 to 1	3 to 1	.....do	1.6	.....do	No work done.
4	Section 5	8	3 to 1	3 to 1	.....do	1.2	.....do	Do.
5	Section 6	8	3 to 1	3 to 1	.....do	.9	.....do	40 per cent in place.

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Fourth district levees, 1904–5—Continued.

BARATARIA LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
					Feet.	*Feet.*	*Feet.*
1	Alliance	998	R.	Geo. H. Conrad	3,042	3,000	7.8
2	Point Michel	1,016	R.	do	2,646	2,500	7.0
3	Woodland	1,010	R.	B. W. Borne	5,053	8,000	8.5

No.	Name of levee.	Date of contract.	Work completed.	Total yardage paid for.	Price per cubic yard.	Total cost.	Grade of levee above highest known water.
					Cents.		*Feet.*
1	Alliance	Sept. 30, 1904	Feb. 9, 1905	30,235.55	17.40	$5,260.98	2.2
2	Point Michel	do	Jan. 3, 1905	15,943.76	23.00	3,667.06	1.6
3	Woodland	Oct. 10, 1904	Mar. 10, 1905	40,726.97	18.49	7,530.42	2.5

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Distance from center of levee to river bank.			Nature of bank.
		Crown.	Land slope.	River slope.			Least.	Greatest.	Average.	
		Feet.	*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	Alliance	8	3 to 1	3 to 1	New	2.5	180	220	190	Caving.
2	Point Michel	8	3 to 1	3 to 1	New and enlargement.	1.2	120	180	140	Stationary.
3	Woodland	8	3 to 1	3 to 1	Enlargement.	1.7	140	300	180	Making.

PONTCHARTRAIN LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
					Feet.	*Feet.*	*Feet.*
	Ophelia:						
1	Section 1	866	L.	M. L. Linnan	558	560	13.7
2	Section 2	866	L.	do	500	530	13.9
3	Section 3	866	L.	do	600	610	13.8
4	Section 4	866	L.	do	600	580	13.7
5	Section 5	866	L.	do	600	630	13.9
6	Section 6	866	L.	do	600	610	13.9
7	Section 7	866	L.	do	500	510	13.7
8	Section 8	866	L.	do	500	490	13.9
9	Section 9	866	L.	do	555	430	13.8
10	Section 10	866	L.	do	892	800	13.9
11	Section 11	866	L.	do	665	752	14.0
	Arizona:						
12	Section 1	873	L.	Menzies & Co	1,065	957	15.5
13	Section 2	873	L.	do	900	850	16.1
14	Section 3	873	L.	do	900	900	15.0
15	Section 4	873	L.	do	800	765	16.1
16	Section 5	873	L.	do	800	804	16.2
17	Section 7	873	L.	do	1,100	1,100	16.8
	Dreyfus:						
18	Section 1	875	L.	do	1,200	1,204	16.0
19	Section 2	875	L.	do	1,000	1,007	15.8
20	Section 3	875	L.	do	1,100	998	15.6
21	Section 4	875	L.	do	1,200	1,200	15.5
22	Section 5	875	L.	do	1,300	1,365	15.1
23	Section 6	875	L.	do	1,300	1,244	15.1
	Southwood:						
24	Section 1	877	L.	do	1,000	1,016	16.5
25	Section 2	877	L.	do	1,100	1,081	17.0
26	Section 7	877	L.	do	954	956	18.8

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Fourth district levees, 1904–5—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
					Feet.	*Feet.*	*Feet.*
	Le Blanc:						
27	Section 1	884	L.	Jas. R. Marlow	788	790	13.5
28	Section 2	884	L.	do	900	878	13.0
29	Section 3	884	L.	do	1,200	1,198	13.4
30	Section 4	884	L.	do	1,200	1,208	14.3
31	Section 5	884	L.	do	800	798	14.0
	Darrow:						
32	Section 1	886	L.	Jordan Bros	400	405	14.2
33	Section 2	886	L.	do	500	492	13.7
34	Section 3	886	L.	do	567	521	14.1
35	Section 4	886	L.	do	1,200	1,127	14.2
36	Section 5	886	L.	do	1,496	1,533	14.4
	Hermitage:						
37	Section 1	888	L.	Hearin & Ryan	1,500	1,531	14.0
38	Section 2	888	L.	do	1,300	1,289	14.1
39	Section 3	888	L.	do	1,400	2,000	13.0
40	Section 4	888	L.	do	1,700	2,000	10.9
41	Section 5	888	L.	do	1,500	1,415	10.8
42	Section 6	888	L.	do	1,471	1,387	13.9
	Marchand:						
43	Section 1	889	L.	Jordan Bros	1,163	1,162	13.9
44	Section 2	889	L.	do	1,300	1,308	14.0
45	Section 3	889	L.	do	978	994	14.4
	Lambert:						
46	Section 1	906	L.	M. L. Linnan	1,300	1,447	10.9
47	Section 2	906	L.	do	1,300	1,470	11.1
48	Section 3	906	L.	do	1,200	1,248	10.7
49	Section 4	906	L.	do	1,300	1,304	10.4
50	Section 5	906	L.	do	1,500	1,506	10.7
51	Section 6	906	L.	do	1,500	1,406	10.5
52	Section 7	906	L.	do	1,400	1,400	13.4
	Oneida:						
53	Section 1	907	L.	do	1,000	998	13.8
54	Section 2	907	L.	do	1,900	1,070	13.4
55	Section 3	907	L.	do	1,200	1,204	13.3
56	Section 4	907	L.	do	1,600	1,519	13.4
	Hester:						
57	Section 4	909	L.	R. T. Clark	1,400	1,325	13.4
	Angelina:						
58	Section 1	917	L.	do	894	843	18.9
59	Section 2	917	L.	do	900	858	19.1
60	Section 3	917	L.	do	835	790	19.0
	Reserve:						
61	Section 1	922	L.	Menzies & Co	1,697	1,665	10.0
62	Section 2	922	L.	do	1,900	1,800	9.0
63	Section 3	922	L.	do	1,500	1,300	9.9
64	Section 4	922	L.	do	1,900	1,504	11.0
65	Section 5	922	L.	do	1,300	1,317	10.0
	Cornland:						
66	Section 1	923.5	L.	do	1,700	1,800	9.5
67	Section 2	923.5	L.	do	1,900	1,847	10.4
68	Section 3	923.5	L.	do	2,000	1,957	9.7
69	Section 4	923.5	L.	do	1,600	1,585	10.8
70	Section 5	923.5	L.	do	1,400	1,433	9.8
	Belle Point:						
71	Section 1	925	L.	do	1,400	1,440	10.7
72	Section 2	925	L.	do	1,700	1,789	11.4
73	Section 3	925	L.	do	2,100	2,134	12.0
74	Section 4	925	L.	do	2,100	2,087	11.8
75	Section 5	925	L.	do	1,808	1,785	13.4
	Good Hope:						
76	Section 1	935	L.	Jordan Bros	1,804	1,807	12.3
77	Section 2	935	L.	do	2,088	2,051	12.4

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Fourth district levees, 1904–5—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

No.	Name of levee.	Date of contract.	Work completed.	Total yardage paid for.	Price per cubic yard.	Total cost.	Grade of levee above highest known water.
	Ophelia:				*Cents.*		*Feet.*
1	Section 1	June 29, 1904	Sept. 8, 1904	13,688.12	13.97	$1,912.23	4.2
2	Section 2	.....do.....	Sept. 26, 1904	13,009.24	13.97	1,817.39	4.2
3	Section 3	.....do.....	Sept. 8, 1904	13,763.89	13.97	1,922.82	4.2
4	Section 4	.....do.....	Aug. 9, 1904	13,241.47	13.97	1,849.83	4.2
5	Section 5	.....do.....	Sept. 26, 1904	13,549.08	13.97	1,892.80	4.2
6	Section 6	.....do.....	July 25, 1904	13,413.49	13.97	1,873.87	4.2
7	Section 7	.....do.....	Aug. 9, 1904	11,643.42	13.97	1,626.58	4.2
8	Section 8	.....do.....	Sept. 8, 1904	12,603.49	13.97	1,760.70	4.2
9	Section 9	.....do.....	Sept. 20, 1904	12,914.51	13.97	1,804.16	4.2
10	Section 10	.....do.....	Aug. 15, 1904	10,577.19	13.97	1,477.63	4.2
11	Section 11	.....do.....	.....do.....	9,008.04	13.97	1,258.42	4.2
	Arizona:						
12	Section 1	Sept. 17, 1904	Dec. 8, 1904	13,196.82	14.40	1,900.34	4.2
13	Section 2	.....do.....	.....do.....	12,596.32	14.40	1,813.87	4.2
14	Section 3	.....do.....	Jan. 11, 1905	12,924.11	14.40	1,861.07	4.2
15	Section 4	.....do.....	Dec. 20, 1904	12,428.27	14.40	1,789.67	4.2
16	Section 5	.....do.....	Feb. 28, 1905	13,601.41	14.40	1,958.60	4.2
17	Section 7	.....do.....	Mar. 20, 1905	14,084.41	14.40	2,021.95	4.2
	Dreyfus:						
18	Section 1	.....do.....	.....do.....	13,375.78	14.40	1,926.11	4.2
19	Section 2	.....do.....	Mar. 30, 1905	13,280.63	14.40	1,905.21	4.2
20	Section 3	.....do.....	Apr. 12, 1905	12,980.28	14.40	1,869.16	4.2
21	Section 4	.....do.....	Apr. 14, 1905	13,008.23	14.40	1,873.19	4.2
22	Section 5	.....do.....	Apr. 30, 1905	13,787.70	14.40	1,985.43	4.2
23	Section 6	.....do.....	.....do.....	13,319.09	14.40	1,917.95	4.2
	Southwood:						
24	Section 1	.....do.....	Apr. 12, 1905	12,480.66	14.40	1,797.22	4.2
25	Section 2	.....do.....	Apr. 26, 1905	14,014.46	14.40	2,018.08	4.2
26	Section 7	.....do.....	Mar. 30, 1905	11,527.54	14.40	1,659.95	4.2
	Le Blanc:						
27	Section 1	.....do.....	Dec. 7, 1904	12,907.14	11.97	1,544.98	4.2
28	Section 2	.....do.....	.....do.....	12,049.90	11.97	1,442.37	4.2
29	Section 3	.....do.....	.....do.....	13,157.19	11.97	1,574.91	4.2
30	Section 4	.....do.....	.....do.....	12,128.36	11.97	1,451.76	4.2
31	Section 5	.....do.....	.....do.....	12,669.29	11.97	1,516.51	4.2
	Darrow:						
32	Section 1	.....do.....	Dec. 23, 1904	10,881.57	11.38	1,238.32	4.2
33	Section 2	.....do.....	.....do.....	18,371.13	11.38	1,521.63	4.2
34	Section 3	.....do.....	Dec. 13, 1904	11,091.24	11.38	1,262.18	4.2
35	Section 4	.....do.....	.....do.....	12,769.98	11.38	1,453.22	4.2
36	Section 5	.....do.....	Dec. 28, 1904	12,431.52	11.38	1,414.71	4.2
	Hermitage:						
37	Section 1	Dec. 19, 1904	Feb. 6, 1905	12,041.17	11.97	1,441.33	4.2
38	Section 2	.....do.....	Feb. 3, 1905	12,179.92	11.97	1,457.98	4.2
39	Section 3	.....do.....	Mar. 4, 1905	12,124.99	11.97	1,441.36	4.2
40	Section 4	.....do.....	.....do.....	12,160.08	11.97	1,455.56	4.2
41	Section 5	.....do.....	.....do.....	11,918.34	11.97	1,416.62	4.2
42	Section 6	.....do.....	.....do.....	12,665.11	11.97	1,516.08	4.2
	Marchand:						
43	Section 1	Sept. 17, 1904	Feb. 26, 1905	11,579.02	11.75	1,360.53	4.2
44	Section 2	.....do.....	.....do.....	12,508.18	11.75	1,469.42	4.2
45	Section 3	.....do.....	.....do.....	11,412.95	11.75	1,341.02	4.2
	Lambert:						
46	Section 1	June 29, 1904	Sept. 20, 1904	11,640.32	13.97	1,626.15	3.9
47	Section 2	.....do.....	.....do.....	11,913.91	13.97	1,664.37	3.9
48	Section 3	.....do.....	Sept. 28, 1904	11,762.05	13.97	1,643.16	3.9
49	Section 4	.....do.....	.....do.....	12,004.71	13.97	1,677.06	3.9
50	Section 5	.....do.....	Oct. 20, 1904	11,428.30	13.97	1,596.53	3.9
51	Section 6	.....do.....	Nov. 29, 1904	11,376.39	13.97	1,589.28	3.9
52	Section 7	.....do.....	Nov. 28, 1904	11,876.12	13.97	1,659.09	3.9
	Oneida:						
53	Section 1	.....do.....	Dec. 7, 1904	11,334.43	13.97	1,583.42	3.9
54	Section 2	.....do.....	Jan. 18, 1905	12,274.52	13.97	1,714.75	3.9
55	Section 3	.....do.....	Mar. 21, 1905	12,153.08	13.97	1,697.78	3.9
56	Section 4	.....do.....	Mar. 25, 1905	11,451.40	13.97	1,599.76	3.9
	Hester:						
57	Section 4	Feb. 24, 1903	Feb. 16, 1905	11,719.96	18.45	2,162.33	3.8
	Angelina:						
58	Section 1	.....do.....	Nov. 1, 1904	10,015.86	18.45	2,490.95	3.8
59	Section 2	.....do.....	Nov. 21, 1904	9,284.46	24.87	2,296.61	3.8
60	Section 3	.....do.....	Dec. 7, 1904	9,296.51	24.87	2,312.04	3.8

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Fourth district levees, 1904–5—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

No.	Name of levee.	Date of contract.	Work completed.	Total yardage paid for.	Price per cubic yard.	Total cost.	Grade of levee above highest known water.
	Reserve:				Cents.		Feet.
61	Section 1	Jan. 19, 1904	July 13, 1904	13,670.09	12.95	$1,770.28	3.8
62	Section 2	do	July 25, 1904	13,457.37	12.95	1,742.73	3.7
63	Section 3	do	Aug. 1, 1904	12,293.00	12.95	1,673.53	3.7
64	Section 4	do	Aug. 19, 1904	13,281.53	12.95	1,719.96	3.7
65	Section 5	do	Aug. 29, 1904	13,995.74	12.95	1,812.45	3.7
	Cornland:						
66	Section 1	do	Sept. 8, 1904	13,107.38	12.95	1,697.41	3.7
67	Section 2	do	Sept. 19, 1904	13,568.64	12.95	1,756.49	3.7
68	Section 3	do	Sept. 29, 1904	13,411.21	12.95	1,736.75	3.6
69	Section 4	do	Oct. 8, 1904	13,418.76	12.95	1,737.72	3.6
70	Section 5	do	Oct. 25, 1904	12,382.27	12.95	1,603.50	3.6
	Belle Point:						
71	Section 1	do	Nov. 3, 1904	13,852.65	13.25	1,835.47	3.6
72	Section 2	do	Nov. 14, 1904	13,708.29	13.25	1,816.35	3.5
73	Section 3	do	Nov. 19, 1904	12,903.01	13.25	1,709.65	3.5
74	Section 4	do	Nov 28, 1904	14,248.34	13.25	1,887.91	3.5
75	Section 5	do	Dec. 3, 1904	14,869.28	13.25	1,970.18	3.4
	Good Hope:						
76	Section 1	June 29, 1904	Sept. 1, 1904	11,540.48	12.98	1,497.96	3.4
77	Section 2	do	do	11,933.84	12.98	1,548.96	3.4

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Distance from center of levee to river bank.			Nature of bank.
		Crown.	Land slope.	River slope.			Least.	Greatest.	Average.	
	Ophelia:	Feet.	Feet.	Feet.		Feet.	Feet.	Feet.	Feet.	
1	Section 1	8	3 to 1	3 to 1	New		200	220	210	Washing.
2	Section 2	8	3 to 1	3 to 1	do		210	230	215	Do.
3	Section 3	8	3 to 1	3 to 1	do		210	235	212	Do.
4	Section 4	8	3 to 1	3 to 1	do		200	220	205	Do.
5	Section 5	8	3 to 1	3 to 1	do		195	205	200	Do
6	Section 6	8	3 to 1	3 to 1	do		195	200	198	Do.
7	Section 7	8	3 to 1	3 to 1	do		150	200	170	Do.
8	Section 8	8	3 to 1	3 to 1	do		200	205	180	Do.
9	Section 9	8	3 to 1	3 to 1	do		80	205	120	Do.
10	Section 10	8	3 to 1	3 to 1	Enlargement.	2.8	220	520	325	Do.
11	Section 11	8	3 to 1	3 to 1	do	2.9	295	525	335	Do.
	Arizona:									
12	Section 1	8	3 to 1	3 to 1	do	2.0	250	400	210	Do.
13	Section 2	8	3 to 1	3 to 1	do	2.2	400	480	450	Caving.
14	Section 3	8	3 to 1	3 to 1	do	2.3	430	600	504	Do.
15	Section 4	8	3 to 1	3 to 1	do	2.5	601	1,104	851	Do.
16	Section 5	8	3 to 1	3 to 1	do	2.6	1,000	1,100	1,025	Do.
17	Section 7	8	3 to 1	3 to 1	do	2.0	300	437	320	Do.
	Dreyfus:									
18	Section 1	8	3 to 1	3 to 1	do	1.9	285	350	300	Do.
19	Section 2	8	3 to 1	3 to 1	do	2.5	200	285	247	Do.
20	Section 3	8	3 to 1	3 to 1	do	2.6	190	360	304	Do.
21	Section 4	8	3 to 1	3 to 1	do	1.8	200	366	240	Do.
22	Section 5	8	3 to 1	3 to 1	do	1.6	295	415	375	Do.
23	Section 6	8	3 to 1	3 to 1	do	2.3	394	415	404	Do.
	Southwood:									
24	Section 1	8	3 to 1	3 to 1	do	2.0	390	515	456	Do.
25	Section 2	8	3 to 1	3 to 1	do	2.1	475	585	550	Do.
26	Section 7	8	3 to 1	3 to 1	do	1.8	634	790	737	Do.
	Le Blanc:									
27	Section 1	8	3 to 1	3 to 1	do	1.9	130	175	150	Stationary.
28	Section 2	8	3 to 1	3 to 1	do	2.1	130	175	153	Do.
29	Section 3	8	3 to 1	3 to 1	do	2.2	133	240	164	Do.
30	Section 4	8	3 to 1	3 to 1	do	2.3	200	220	203	Do.
31	Section 5	8	3 to 1	3 to 1	New and enlargement.	2.3	170	231	203	Washing.
	Darrow:									
32	Section 1	8	3 to 1	3 to 1	New		190	210	200	Do.
33	Section 2	8	3 to 1	3 to 1	do		218	270	243	Do.
34	Section 3	8	3 to 1	3 to 1	New and enlargement.	2.2	267	326	303	Do.

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Fourth district levees, 1904–5—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Distance from center of levee to river bank.			Nature of bank.
		Crown.	Land slope.	River slope.			Least.	Greatest.	Average.	
	Darrow—Con.	*Feet.*	*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	
35	Section 4..	8	3 to 1	3 to 1	Enlargement.	2.0	256	348	307	Washing.
36	Section 5..	8	3 to 1	3 to 1	....do....	1.5	171	241	135	Do.
	Hermitage:									
37	Section 1..	8	3 to 1	3 to 1	....do....	1.3	164	300	200	Caving.
38	Section 2..	8	3 to 1	3 to 1	....do....	1.4	200	320	305	Do.
39	Section 3..	8	3 to 1	3 to 1	....do....	1.5	245	400	308	Washing.
40	Section 4..	8	3 to 1	3 to 1	....do....	2.0	240	250	304	Stationary.
41	Section 5..	8	3 to 1	3 to 1	....do....	1.8	300	370	340	Do.
42	Section 6..	8	3 to 1	3 to 1	....do....	2.1	317	400	385	Making.
	Marchand:									
43	Section 1..	8	3 to 1	3 to 1	....do....	2.5	253	310	278	Stationary.
44	Section 2..	8	3 to 1	3 to 1	....do....	2.7	210	401	297	Do.
45	Section 3..	8	3 to 1	3 to 1	....do....	3.0	298	407	389	Do.
	Lambert:									
46	Section 1..	8	3 to 1	3 to 1	....do....	2.9	400	504	474	Making.
47	Section 2..	8	3 to 1	3 to 1	....do....	2.8	329	552	431	Do.
48	Section 3..	8	3 to 1	3 to 1	....do....	2.0	327	475	437	Do.
49	Section 4..	8	3 to 1	3 to 1	....do....	2.7	431	465	441	Do.
50	Section 5..	8	3 to 1	3 to 1	....do....	2.4	425	465	438	Do.
51	Section 6..	8	3 to 1	3 to 1	....do....	2.5	389	421	404	Stationary.
52	Section 7..	8	3 to 1	3 to 1	....do....	2.6	294	375	348	Do.
	Oneida:									
53	Section 1..	8	3 to 1	3 to 1	....do....	2.6	284	371	347	Do.
54	Section 2..	8	3 to 1	3 to 1	....do....	2.5	248	359	304	Do.
55	Section 3..	8	3 to 1	3 to 1	....do....	2.1	252	261	307	Do.
56	Section 4..	8	3 to 1	3 to 1	....do....	1.9	184	252	207	Washing.
	Hester:									
57	Section 4..	8	3 to 1	3 to 1	....do....	2.0	285	500	380	Caving.
	Angelina:									
58	Section 1..	8	3 to 1	3 to 1	....do....	3.4	490	550	520	Do.
59	Section 2..	8	3 to 1	3 to 1	....do....	3.2	493	536	510	Do.
60	Section 3..	8	3 to 1	3 to 1	....do....	3.6	525	560	530	Do.
	Reserve:									
61	Section 1..	8	3 to 1	3 to 1	....do....	2.8	133	210	167	Stationary.
62	Section 2..	8	3 to 1	3 to 1	....do....	2.1	120	230	188	Do.
63	Section 3..	8	3 to 1	3 to 1	....do....	2.3	145	300	217	Washing.
64	Section 4..	8	3 to 1	3 to 1	....do....	2.3	152	350	234	Do.
65	Section 5..	8	3 to 1	3 to 1	....do....	2.3	225	243	232	Stationary.
	Cornland:									
66	Section 1..	8	3 to 1	3 to 1	....do....	2.1	134	220	165	Do.
67	Section 2..	8	3 to 1	3 to 1	....do....	2.8	90	270	270	Do.
68	Section 3..	8	3 to 1	3 to 1	....do....	2.5	75	267	157	Do.
69	Section 4..	8	3 to 1	3 to 1	....do....	3.0	70	140	112	Do.
70	Section 5..	8	3 to 1	3 to 1	....do....	3.4	62	120	92	Do.
	Belle Point:									
71	Section 1..	8	3 to 1	3 to 1	....do....	3.0	85	150	113	Do.
72	Section 2..	8	3 to 1	3 to 1	....do....	2.5	140	229	173	Do.
73	Section 3..	8	3 to 1	3 to 1	....do....	2.2	178	220	212	Making.
74	Section 4..	8	3 to 1	3 to 1	....do....	2.3	178	220	206	Do.
75	Section 5..	8	3 to 1	3 to 1	....do....	2.6	214	280	243	Do.
	Good Hope:									
76	Section 1..	8	3 to 1	3 to 1	....do....	2.8	181	200	188	Stationary.
77	Section 2..	8	3 to 1	3 to 1	....do....	2.7	120	195	174	Do.

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Fourth district levees, 1904–5—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

[Uncompleted levees.]

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
	Arizona:				Feet.	Feet.	Feet.
1	Section 6	873	L.	Menzies & Co	800	550	17.0
	Dreyfus:						
2	Section 7	875	L.	do	1,192	1,242	15.3
	Southwood:						
3	Section 3	877	L.	do	1,100	998	15.5
4	Section 4	877	L.	do	1,200	1,200	15.5
5	Section 5	877	L.	do	1,300	1,365	15.1
6	Section 6	877	L.	do	1,300	1,244	15.1
	Oneida:						
7	Section 5	907	L.	M. L. Linnan	1,398	1,077	16.5
8	Section 6	907	L.	do	1,526	1,527	18.0
9	Section 7	907	L.	do	1,407	1,408	17.1
	Belmont:						
10	Section 1	908	L.	R. T. Clark	1,300	1,220	15.5
11	Section 2	908	L.	do	1,200	1,121	15.6
12	Section 3	908	L.	do	1,100	941	13.3
	Hester:						
13	Section 1	909	L.	do	1,000	949	16.5
14	Section 2	909	L.	do	1,100	1,054	15.4

No.	Name of levee.	Date of contract.	Total yardage.	Price per cubic yard.	Distance from center of levee to river bank.			Grade of levee above highest known water.
					Least.	Greatest.	Average.	
	Arizona:			Cents.	Feet.	Feet.	Feet.	Feet.
1	Section 6	Sept. 17, 1904	13,108.66	14.40	450	1,104	759	4.2
	Dreyfus:							
2	Section 7	do	12,601.28	14.40	384	410	396	4.2
	Southwood:							
3	Section 3	do	14,089.99	14.40	190	360	304	4.2
4	Section 4	do	13,397.97	14.40	200	366	240	4.2
5	Section 5	do	13,970.30	14.40	295	415	375	4.2
6	Section 6	do	12,837.57	14.40	394	415	404	4.2
	Oneida:							
7	Section 5	June 29, 1904	11,088.30	13.97	115	501	308	3.9
8	Section 6	do	12,086.85	13.97	500	584	562	3.9
9	Section 7	do	12,089.60	13.97	511	574	567	3.9
	Belmont:							
10	Section 1	Feb. 24, 1903	14,378.11	18.45	500	560	510	3.8
11	Section 2	do	13,831.73	18.45	460	590	515	3.8
12	Section 3	do	14,289.97	18.45	450	490	470	4.0
	Hester:							
13	Section 1	do	11,951.08	18.45	430	565	550	3.8
14	Section 2	do	13,070.36	18.45	350	675	495	3.8

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Nature of bank.	Condition of contract.
		Crown.	Land slope.	River slope.				
	Arizona:	Feet.	Feet.	Feet.		Feet.		
1	Section 6.	8	3 to 1	3 to 1	Enlargement.	2.3	Caving	98 per cent in place.
	Dreyfus:							
2	Section 7.	8	3 to 1	3 to 1	do	2.0	do	Do.
	Southwood:							
3	Section 3.	8	3 to 1	3 to 1	do	2.1	do	92 per cent in place.
4	Section 4.	8	3 to 1	3 to 1	do	1.9	do	No work done.
5	Section 5.	8	3 to 1	3 to 1	do	1.8	do	Do.
6	Section 6.	8	3 to 1	3 to 1	do	1.8	do	16 per cent in place.
	Oneida:							
7	Section 5.	8	3 to 1	3 to 1	do	2.0	do	20 per cent in place
8	Section 6.	8	3 to 1	3 to 1	do	2.1	do	No work done.
9	Section 7.	8	3 to 1	3 to 1	do	1.8	do	31 per cent in place.
	Belmont:							
10	Section 1.	8	3 to 1	3 to 1	do	2.7	do	No work done.
11	Section 2.	8	3 to 1	3 to 1	do	3.0	do	Do.
12	Section 3.	8	3 to 1	3 to 1	do	3.4	do	Do.
	Hester:							
13	Section 1.	8	3 to 1	3 to 1	do	2.7	do	35 per cent in place.
14	Section 2.	8	3 to 1	3 to 1	do	2.9	do	99 per cent in place.

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Fourth district levees, 1904–5—Continued.

LAKE BORGNE LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Average height above ground surface.
					Feet.	*Feet.*	*Feet.*
1	Burton to Louderbough.	1,022	L.	Jas. Cleary	6,480	6,600	6.3
2	Harris to Point Pleasant.	1,027	L.	Jos. Hingle	10,741	9,000	6.1
3	Vogt	1,024	L.	B. W. Borne	4,022	4,500	6.0

No.	Name of levee.	Date of contract.	Work completed.	Total yardage paid for.	Price per cubic yards.	Total cost.	Grade of levee above highest known water.
					Cents.		*Feet.*
1	Burton to Louderbough	Sept. 15, 1904	Dec. 24, 1904	27,263.10	17.00	$4,634.78	1.6
2	Harris to Point Pleasant	....do	Dec. 20, 1904	34,239.85	15½	5,364.25	1.7
3	Vogt	Oct. 10, 1904	Mch. 2, 1905	15,102.89	20.00	3,020.58	1.7

No.	Name of levee.	Section.			New or enlargement.	Average height above old levee.	Distance from center of levee to river bank.			Nature of bank.
		Crown.	Land slope.	River slope.			Least.	Greatest.	Average.	
		Feet.	*Feet.*	*Feet.*		*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	Burton to Louderbough.	8	3 to 1	3 to 1	Enlargement.	1.3	150	200	100	Stationary.
2	Harris to Point Pleasant.	8	3 to 1	3 to 1	....do...	1.4	180	400	320	Caving.
3	Vogt	8	3 to 1	3 to 1	....do...	1.6	180	250	150	Making.

Percentage of length of existing levee system built wholly or in part by the United States.

District.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Lower Tensas	59	63	66	72	71.0	71	72	78.0	78.0	68.0
Atchafalaya	47	68	65	67	68.0	69	68	67.9	68.0	65.5
Lafourche	54	61	61	62	75.0	82	83	78.0	77.7	77.6
Barataria	30	43	50	54	63.0	55	55	55.0	55.0	56.5
Pontchartrain	63	74	75	77	80.0	78	78	79.0	80.0	86.9
Lake Borgne	53	60	65	66	44.5	46	46	46.0	44.5	49.7

Percentage of total length of existing levee system, fourth district, improving Mississippi River, built wholly or in part by the United States.

Year.	Percentage.	Year.	Percentage.
	Per cent.		*Per cent.*
1893	13.8	1900	67.2
1894	26.2	1901	68.7
1895	36.2	1902	69.0
1896	52.0	1903	68.6
1897	63.0	1904	66.3
1898	65.0	1905	66.5
1899	66.0		

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Tabulated statement showing condition of levees and levee work for period from May 1, 1904, to May 1, 1905.

Levee district.	In system.	Built.	Contents in 1904.	Built since by United States.	Built since by local authorities.	Constructed in 1905.
	Miles.	*Miles.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*
Lower Tensas	160.24	142.76	18,863,026	25,592	772,287	797,879
Atchafalaya	128.46	128.46	20,165,036	318,219	863,782	1,182,001
Lafourche	82.16	82.16	8,523,894	242,933	52,307	295,240
Barataria	71.88	71.88	2,972,886	86,906	187,904	274,810
Pontchartrain	125.64	125.64	15,501,382	961,708	274,133	1,235,841
Lake Borgne	77.07	77.07	3,564,796	76,606	125,189	201,795
Total	645.45	627.97	69,590,970	1,711,964	2,275,602	3,987,566

Levee district.	Lost during year.	Contents in 1905.	Required to complete.	Estimated final contents.	Percentage now built.
	Cu. yards.	*Cu. yards.*	*Cu. yards.*	*Cu. yards.*	
Lower Tensas	316,122	19,344,783	12,525,950	31,870,733	67
Atchafalaya	400,200	20,946,837	4,775,900	25,722,737	81
Lafourche	None.	8,819,134	2,585,462	11,404,596	77
Barataria	61,470	3,186,176	1,196,220	4,382,396	73
Pontchartrain	127,097	16,610,126	5,098,898	21,709,024	77
Lake Borgne	54,350	3,712,241	1,412,734	5,124,973	72
Total	959,239	72,619,297	27,595,164	100,214,459	72

LOWER TENSAS LEVEE DISTRICT.

The amount expended from June 30, 1904, to June 30, 1905, is $20,263.03, distributed as follows:

Office expenses, main office	$564.90
Other administrative expenses	2,302.42
Construction of levees (contracts)	14,985.26
Surveys	2,256.55
Repairs to plant	37.50
Care of plant	111.90
New plant	4.50
Total	20,263.03

Money statement.

July 1, 1904, balance unexpended	$33,095.83
Amount allotted from sundry civil act approved April 28, 1904	110,000.00
Amount allotted from sundry civil act approved March 3, 1905	110,000.00
Amount allotted from river and harbor act approved March 3, 1905	85,000.00
	338,095.83
June 30, 1905, amount expended during fiscal year, for works of improvement	20,263.03
July 1, 1905, balance unexpended	317,832.80
July 1, 1905, outstanding liabilities	297.41
July 1, 1905, balance available	317,535.39
Amount (estimated) required for completion of existing project	Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905:	
For works of improvement	$300,000.00
For maintenance of improvement	5,000.00
	305,000.00

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

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ABSTRACT OF APPROPRIATIONS.

"Levees, Tensas front:"	
By act of Congress of—	
August 2, 1882 (river and harbor act), allotted	$426,160.00
January 19, 1884 (river and harbor act), allotted	21,000.00
January 19, 1884 (river and harbor act), allotted by transfer	3,000.00
July 5, 1884 (river and harbor act), allotted	98,710.00
July 5, 1884 (river and harbor act), allotted by transfer	3,400.00
August 5, 1886 (river and harbor act), allotted	11,100.00
August 5, 1886 (river and harbor act), allotted	15,000.00
August 5, 1886 (river and harbor act), allotted	150,000.00
August 11, 1888 (river and harbor act), allotted	[a] 160,000.00
	888,370.00
"Levees, Tensas Basin:"	
By act of Congress of—	
September 19, 1890 (river and harbor act), allotted	199,500.00
September 19, 1890 (river and harbor act), allotted by transfer	38,475.00
September 19, 1890 (river and harbor act), allotted by transfer	11,542.50
September 19, 1890 (river and harbor act), allotted by transfer	1,334.75
September 19, 1890 (river and harbor act), allotted by transfer	3,000.00
August 5, 1886 (river and harbor act), reallotted from sales	21.00
	253,873.25
"Lower Tensas levee district:"	
By act of Congress of—	
July 13, 1892 (river and harbor act), allotted	150,000.00
March 3, 1893 (sundry civil act), allotted	132,000.00
August 17, 1894 (sundry civil act), allotted	132,000.00
March 3, 1895 (sundry civil act), allotted	132,000.00
June 3, 1896 (river and harbor act), allotted	45,000.00
June 4, 1897 (river and harbor act), allotted	228,700.00
July 19, 1897 (deficiency act), allotted	45,000.00
July 1, 1898 (sundry civil act), allotted	158,000.00
March 3, 1899 (sundry civil act), allotted	217,300.00
June 6, 1900 (sundry civil act), allotted	110,000.00
June 13, 1902 (river and harbor act), allotted	110,000.00
March 3, 1903 (sundry civil act), allotted	110,000.00
April 28, 1904 (sundry civil act), allotted	110,000.00
March 3, 1905 (sundry civil act), allotted	110,000.00
March 3, 1905 (river and harbor act), allotted	85,000.00
	1,875,000.00
Grand total	3,017,243.25

ATCHAFALAYA LEVEE DISTRICT.

The amount expended from June 30, 1904, to June 30, 1905, is $67,408.89, distributed as follows:

Office expenses, main office	$1,821.65
Other administrative expenses	4,425.96
Construction of levees (contracts)	60,737.34
Surveys	74.90
Repairs to plant	103.58
Care of plant	229.20
New plant	16.26
Total	67,408.89

[a] Original allotment $175,000. Of this amount $5,000 was transferred to protection of third district and $10,000 to protection of fourth district.

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Money statement.

July 1, 1904, balance unexpended	$52,787.90
Amount allotted from sundry civil act approved April 28, 1904	40,000.00
Amount allotted from sundry civil act approved March 3, 1905	40,000.00
Amount allotted from river and harbor act approved March 3, 1905	30,000.00
Total	162,787.90
June 30, 1905, amount expended during fiscal year, for works of improvement	67,408.89
July 1, 1905, balance unexpended	95,379.01
July 1, 1905, amount covered by uncompleted contracts	6,606.78
Amount (estimated) required for completion of existing project	Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905:	
For works of improvement $25,000.00	
For maintenance of improvement 4,000.00	29,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	

ABSTRACT OF APPROPRIATIONS.

"Atchafalaya front:"

By act of Congress of—	
August 2, 1882 (River and harbor act), allotted	$110,000.00
January 19, 1884 (River and harbor act), allotted	5,000.00
January 19, 1884 (River and harbor act), allotted	4,000.00
January 19, 1884 (River and harbor act), allotted	15,000.00
January 19, 1884 (River and harbor act), allotted	[a] 9,000.00
August 5, 1886 (River and harbor act), allotted	40,000.00
	183,000.00

"Levees right bank below Red River:"

By act of Congress of—	
September 19, 1890 (River and harbor act), allotted	123,975.00
September 19, 1890 (River and harbor act), allotted by transfer	41,562.50
September 19, 1890 (River and harbor act), allotted	12,468.75
September 19, 1890 (River and harbor act), allotted by transfer	1,441.15
	179,447.40

"Atchafalaya levee district:"

By act of Congress of—	
July 13, 1892 (River and harbor act), allotted	155,000.00
March 3, 1893 (Sundry civil act), allotted	152,000.00
August 17, 1894 (Sundry civil act), allotted	152,000.00
March 2, 1895 (Sundry civil act), allotted	152,000.00
June 6, 1896 (River and harbor act), allotted	28,125.00
June 4, 1897 (River and harbor act), allotted	138,600.00
July 19, 1897 (Deficiency act), allotted	28,125.00
July 1, 1898 (Sundry civil act), allotted	87,000.00
March 3, 1899 (Sundry civil act), allotted	98,800.00
June 6, 1900 (Sundry civil act), allotted	55,000.00
June 13, 1902 (River and harbor act), allotted	40,000.00
March 3, 1903 (Sundry civil act), allotted	40,000.00
April 28, 1904 (Sundry civil act), allotted	40,000.00
March 3, 1905 (Sundry civil act), allotted	40,000.00
March 3, 1905 (River and harbor act), allotted	30,000.00
	1,236,650.00
Grand total	1,599,097.40

[a] Original allotment $12,000. $3,000 transferred to Tensas front.

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LAFOURCHE LEVEE DISTRICT.

The amount expended from June 30, 1904, to June 30, 1905, is $41,052.75, distributed as follows:

Office expenses, main office	$1,761.32
Other administrative expenses	3,548.00
Construction of levees (contracts)	35,165.90
Repairs to plant	325.85
Care of plant	245.68
New plant	6.00
Total	41,052.75

Money statement.

July 1, 1904, balance unexpended		$11,056.51
Amount allotted from sundry civil act approved April 28, 1904		40,000.00
Amount allotted from sundry civil act approved March 3, 1905		40,000.00
Amount allotted from river and harbor act approved March 3, 1905		15,000.00
		106,056.51
June 30, 1905, amount expended during fiscal year, for works of improvement		41,052.75
July 1, 1905, balance unexpended		65,003.76
July 1, 1905, amount covered by uncompleted contracts		2,838.59
Amount (estimated) required for completion of existing project		Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905:		
For works of improvement	$15,000.00	
For maintenance of improvement	2,000.00	
		17,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

ABSTRACT OF APPROPRIATIONS.

By act of Congress of—	
July 13, 1892 (river and harbor act), allotted	$90,000.00
March 3, 1893 (sundry civil act), allotted	90,000.00
August 17, 1894 (sundry civil act), allotted	90,000.00
March 3, 1895 (sundry civil act), allotted	90,000.00
June 6, 1896 (river and harbor act), allotted	8,437.50
June 4, 1897 (river and harbor act), allotted	41,600.00
July 19, 1897 (deficiency act), allotted	8,437.50
July 1, 1898 (sundry civil act), allotted	36,000.00
March 3, 1899 (sundry civil act), allotted	37,050.00
June 6, 1900 (sundry civil act), allotted	28,000.00
June 13, 1902 (river and harbor act), allotted	20,000.00
March 3, 1903 (sundry civil act), allotted	20,000.00
April 28, 1904 (sundry civil act), allotted	40,000.00
March 3, 1905 (sundry civil act), allotted	40,000.00
March 3, 1905 (river and harbor act), allotted	15,000.00
Total	654,525.00

BARATARIA LEVEE DISTRICT.

The amount expended from June 30, 1904, to June 30, 1905, is $22,921.43, distributed as follows:

Office expenses, main office	$728.58
Other administrative expenses	2,119.15
Construction of levees (contracts)	16,250.96
Surveys	2,448.48
Repairs to levees	1,231.78
Repairs to plant	53.00
Care of plant	89.48
Total	22,921.43

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Money statement.

July 1, 1904, balance unexpended		$9,260.98
Amount allotted from sundry civil act approved April 28, 1904		15,000.00
Amount allotted from sundry civil act approved March 3, 1905		15,000.00
Amount allotted from the river and harbor act approved March 3, 1905		15,000.00
		54,260.98
June 30, 1905, amount expended during fiscal year:		
For works of improvement	$21,689.65	
For maintenance of improvement	1,231.78	
		22,921.43
July 1, 1905, balance unexpended		31,339.55
Amount (estimated) required for completion of existing project		Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905:		
For works of improvement	$15,000.00	
For maintenance of improvement	2,000.00	
		17,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

ABSTRACT OF APPROPRIATIONS.

By act of Congress of—	
July 13, 1892 (river and harbor act), allotted	$60,000.00
March 3, 1893 (sundry civil act), allotted	60,000.00
August 17, 1894 (sundry civil act), allotted	60,000.00
March 2, 1895 (sundry civil act), allotted	60,000.00
June 3, 1896 (river and harbor act), allotted	3,937.50
June 4, 1897 (river and harbor act), allotted	19,400.00
July 19, 1897 (deficiency act), allotted	3,937.50
July 1, 1898 (sundry civil act), allotted	27,000.00
March 3, 1899 (sundry civil act), allotted	24,700.00
June 6, 1900 (sundry civil act), allotted	14,000.00
June 13, 1902 (river and harbor act), allotted	10,000.00
March 3, 1903 (sundry civil act), allotted	10,000.00
April 28, 1904 (sundry civil act), allotted	15,000.00
March 3, 1905 (sundry civil act), allotted	15,000.00
March 3, 1905 (river and harbor act), allotted	15,000.00
Total	397,975.00

PONTCHARTRAIN LEVEE DISTRICT.

The amount expended from June 30, 1904, to June 30, 1905, is $87,131.80, distributed as follows:

Office expenses, main office	$904.52
Other administrative expenses	4,537.00
Construction of levees (contracts)	79,033.21
Surveys	173.77
Repairs to levees	2,053.96
Care of plant	429.34
Total	87,131.80

Money statement.

July 1, 1904, balance unexpended	$39,033.12
Amount allotted from sundry civil act approved April 28, 1904	90,000.00
Amount allotted from sundry civil act approved March 3, 1905	90,000.00
Amount allotted from river and harbor act approved March 3, 1905	60,000.00
	279,033.12

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June 30, 1905, amount expended during fiscal year:		
For works of improvement	$85,077.84	
For maintenance of improvement	2,053.96	
		$87,131.80
July 1, 1905, balance unexpended		191,901.32
July 1, 1905, amount covered by uncompleted contracts		85,700.48
Amount (estimated) required for completion of existing project		Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905:		
For works of improvement	$125,000.00	
For maintenance of improvement	5,000.00	
		130,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

ABSTRACT OF APPROPRIATIONS.

"Levees, left bank below Red River:"	
By act of Congress of—	
September 19, 1890 (river and harbor act), allotted	$89,775.00
September 19, 1890 (river and harbor act), allotted by transfer	21,850.00
September 19, 1890 (river and harbor act), allotted	6,750.70
September 19, 1890 (river and harbor act), allotted	780.90
	119,156.60
"Pontchartrain levee district:"	
By act of Congress of—	
July 13, 1892 (river and harbor act), allotted	150,000.00
March 3, 1893 (sundry civil act), allotted	150,000.00
August 17, 1894 (sundry civil act), allotted by transfer	4,633.04
August 17, 1894 (sundry civil act), allotted	150,000.00
March 2, 1895 (sundry civil act), allotted	150,000.00
June 3, 1896 (river and harbor act), allotted	22,500.00
June 4, 1897 (river and harbor act), allotted	113,150.00
July 19, 1897 (deficiency act), allotted	22,500.00
July 1, 1898 (sundry civil act), allotted	76,000.00
March 3, 1899 (sundry civil act), allotted	74,100.00
June 6, 1900 (sundry civil act), allotted	50,000.00
June 13, 1902 (river and harbor act), allotted	101,500.00
March 3, 1903 (sundry civil act), allotted	81,500.00
April 28, 1904 (sundry civil act), allotted	90,000.00
March 3, 1905 (sundry civil act), allotted	90,000.00
March 3, 1905 (river and harbor act), allotted	60,000.00
	1,385,883.04
Grand total	1,505,039.64

LAKE BORGNE LEVEE DISTRICT.

The amount expended from June 30, 1904, to June 30, 1905, is $15,936.27, distributed as follows:

Office expenses, main office	$206.82
Other administrative expenses	843.35
Construction of levees (contract)	12,931.73
Surveys	968.51
Repairs to levees	985.36
Repairs to plant	.50
Total	15,936.27

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Money statement.

July 1, 1904, balance unexpended		$1,885.99
Amount allotted from sundry civil act approved April 28, 1904		15,000.00
Amount allotted from sundry civil act approved March 3, 1905		15,000.00
Amount allotted from river and harbor act approved March 3, 1905		15,000.00
		46,885.99
June 30, 1905, amount expended during fiscal year:		
For works of improvement	$14,950.91	
For maintenance of improvement	985.36	
		15,936.27
July 1, 1905, balance unexpended		30,949.72
Amount (estimated) required for completion of existing project		Indeterminate.
Amount that can be profitably expended in fiscal year ending June 30, 1907, in addition to the balance unexpended July 1, 1905:		
For works of improvement	$10,000.00	
For maintenance of improvement	2,000.00	
		12,000.00
Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.		

ABSTRACT OF APPROPRIATIONS.

By act of Congress of—	
July 13, 1892 (river and harbor act), allotted	$50,000
March 3, 1893 (sundry civil act), allotted	50,000
August 17, 1894 (sundry civil act), allotted	50,000
March 2, 1895 (sundry civil act), allotted	50,000
June 3, 1896 (river and harbor act), allotted	4,500
June 4, 1897 (river and harbor act), allotted	22,200
July 19, 1897 (deficiency act), allotted	4,500
July 1, 1898 (sundry civil act), allotted	24,000
March 3, 1899 (sundry civil act), allotted	24,700
June 6, 1900 (sundry civil act), allotted	14,500
June 13, 1902 (river and harbor act), allotted	10,000
June 13, 1902 (river and harbor act), allotted	2,000
March 3, 1903 (sundry civil act), allotted	10,000
April 28, 1904 (sundry civil act), allotted	15,000
March 3, 1905 (sundry civil act), allotted	15,000
March 3, 1905 (river and harbor act), allotted	15,000
Total	361,400

The following maps and appendixes accompany and form part of this report:

Plate I.—Bondurant Chute revetment.
Plate II.—Kempe Bend revetment.
Plate III.—Giles Bend revetment.
Plate IV.—Dredged channel, mouth of Old River.
Plate V.—New Orleans Harbor.
Plate VI.—Lower Tensas and Homochitto levee districts.
Plate VII.—Atchafalaya, Lafourche, and Pontchartrain levee districts.
Plate VIII.—Barataria and Lake Borgne levee districts.
Appendix A.—Abstract of contracts in force.
Appendix B.—Commercial statistics.
Appendix C.—Report of H. S. Douglas, assistant engineer.
Appendix D.—Report of E. B. Geddes, assistant engineer.
Appendix E.—Report of W. E. Knobloch, superintendent.

Very respectfully, your obedient servant,

J. F. McINDOE,
Captain, Corps of Engineers.

Col. O. H. ERNST,
Corps of Engineers, U. S. Army,
President Mississippi River Commission.

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Plate I.

Mississippi River.

South A

In char

Capt. J. F. McIn. U.S. Army.

Sondura

H. S. Douglas.

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Note: Contours are from surface sinking of mattresses, and refer to a pro datum.
To accompany Ar - 05.

of Engineers. U.S. Army.

March 1905.

in 1900-01.

1900-01-02-03-04.

ed in 1902-03.

Rock pavement placed in 1905.

Nov. 1904

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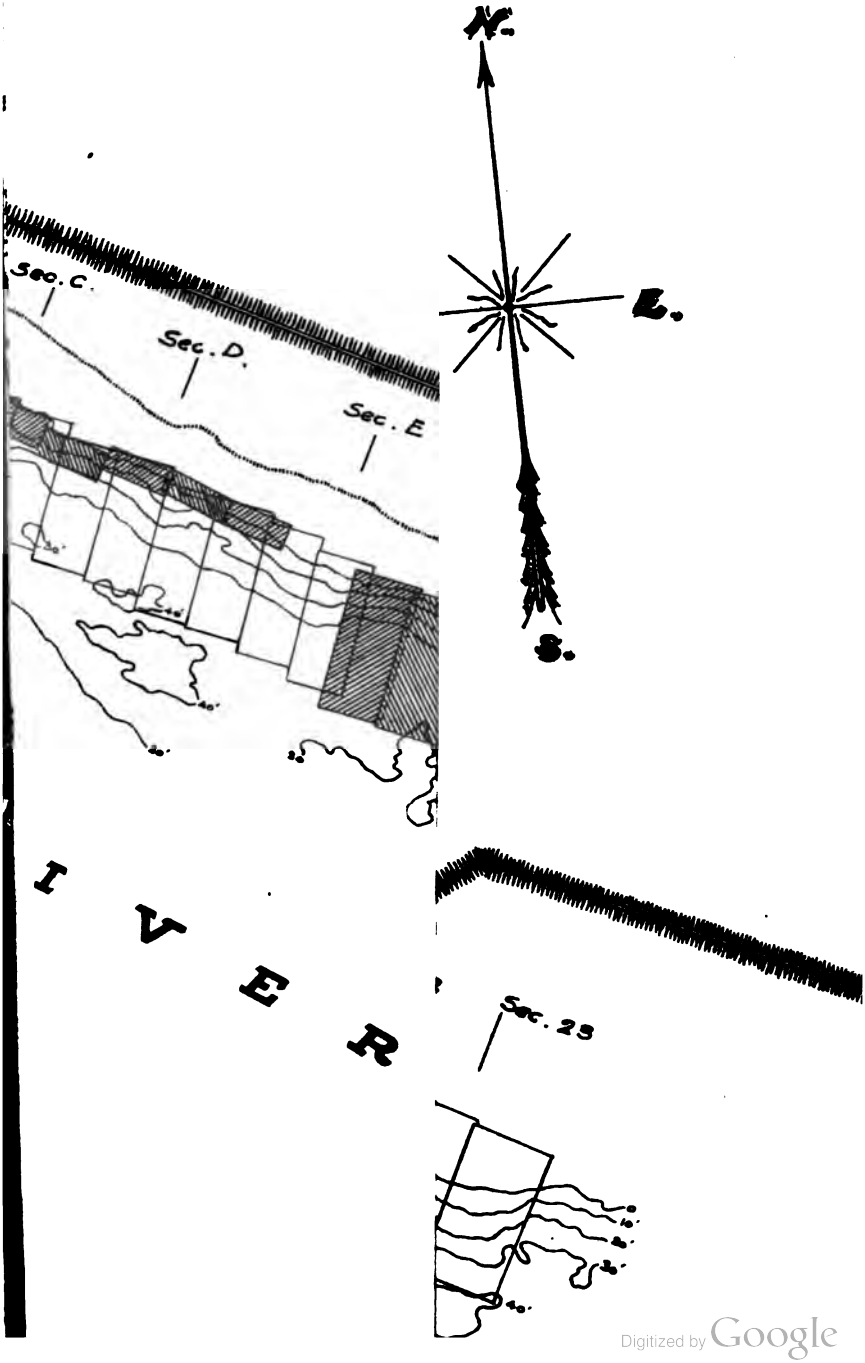
Plate II.



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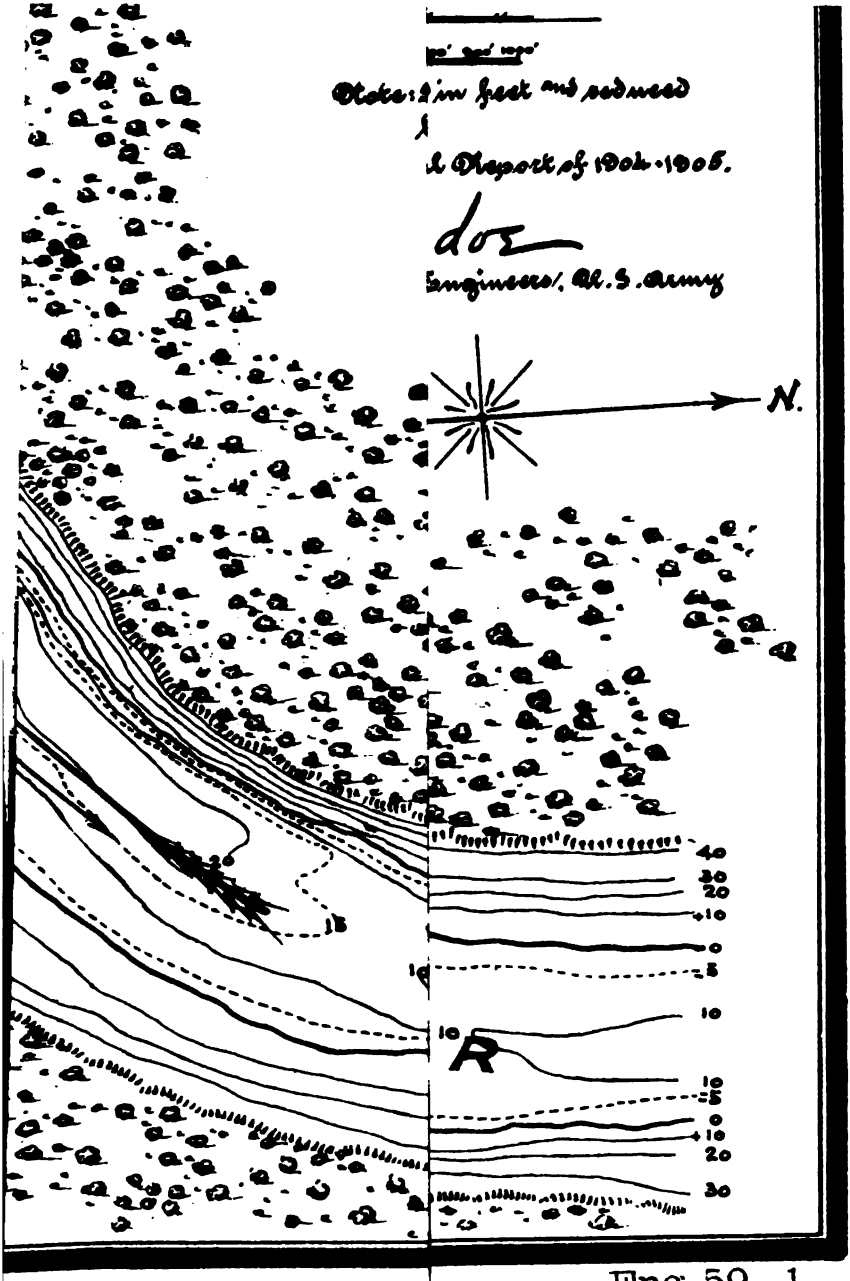

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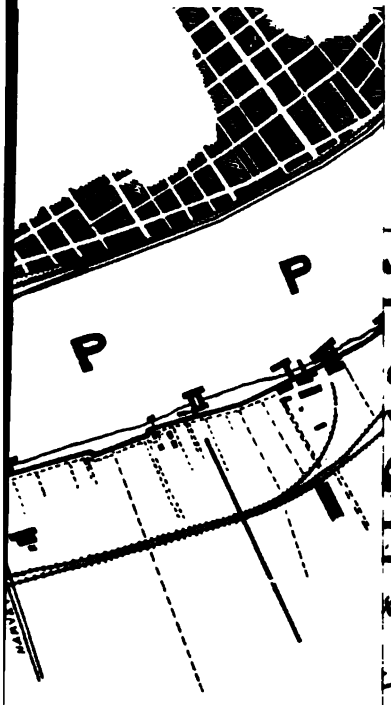

Engineer, U.S.A.
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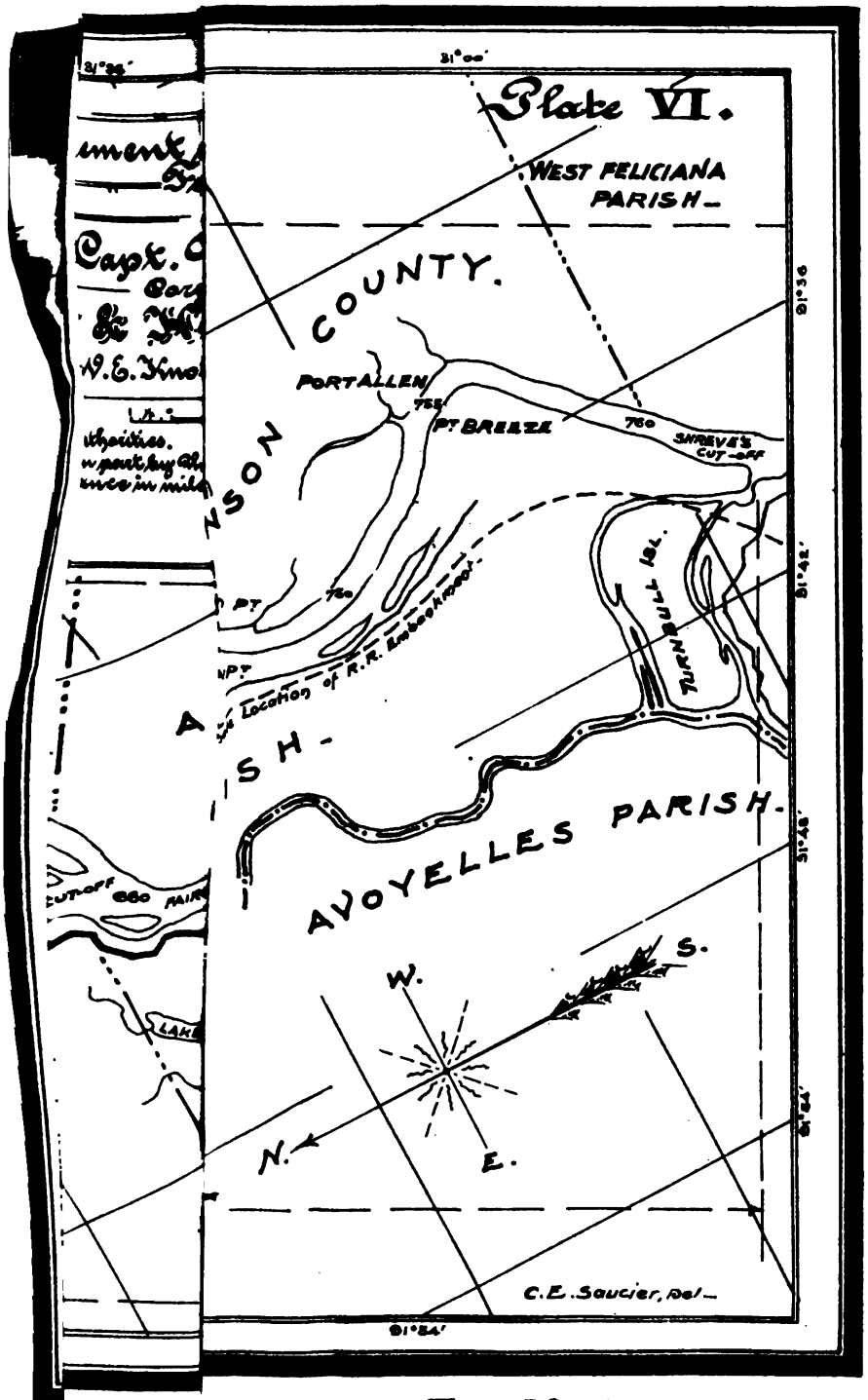

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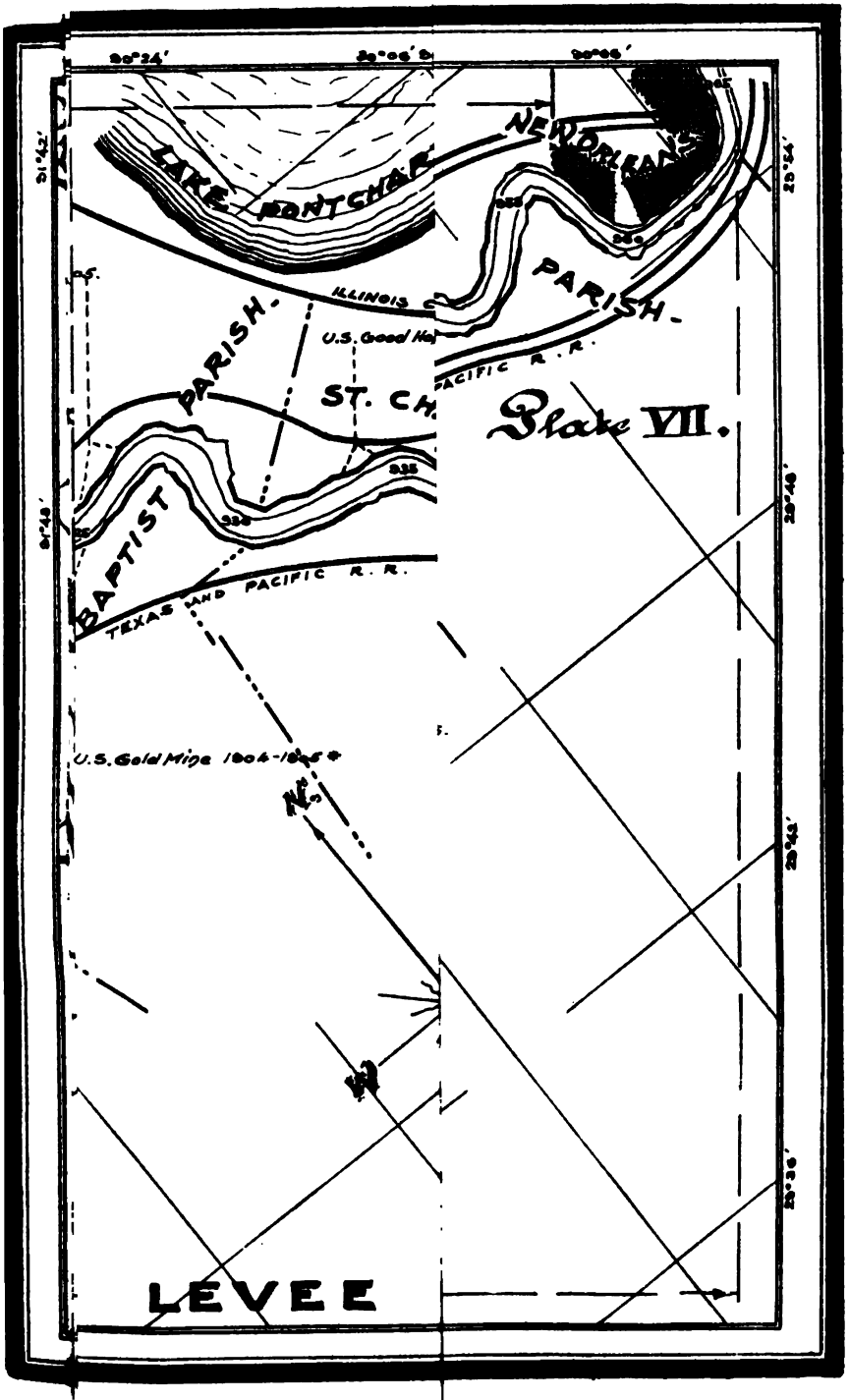

Plate VII.

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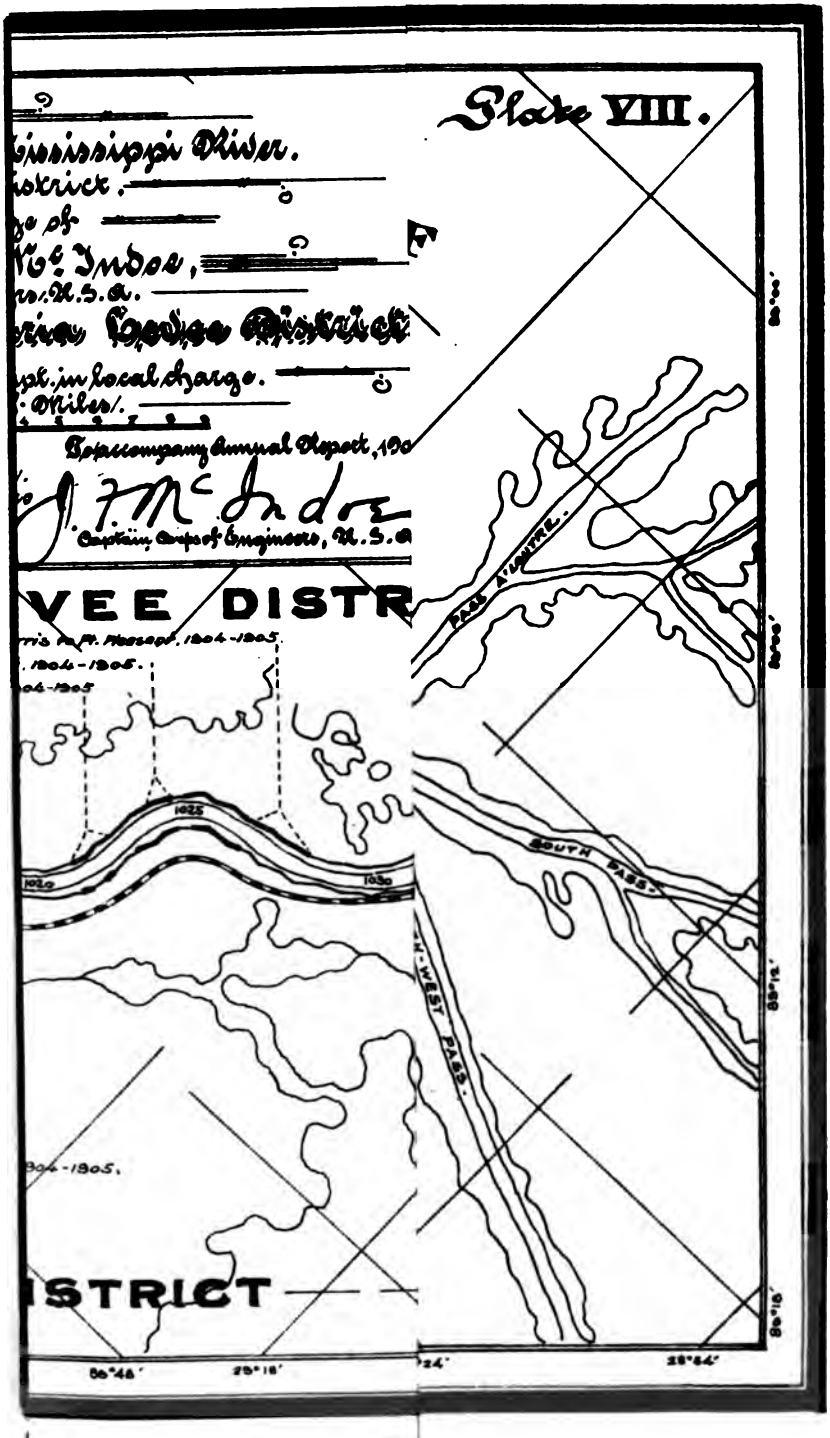

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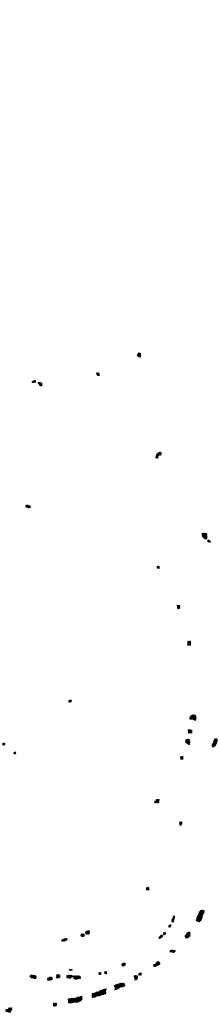

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APPENDIX 4 A.

Abstract of contracts in force during fiscal year ending June 30, 1905, fourth district, improving Mississippi River.

Name of contractor.	Amount and character of work.	Unit price.	Date of approval.	Date of beginning work.	Date of expiration of contract.
Menzies & Co	78,000 cubic yards levee work. 26,000 cubic yards levee work.	14.5 cents	Emergency	Dec. 13, 1902	Dec. 24, 1904
Jas. R. Marlow	77,000 cubic yards levee work.	19.25 cents	do	Dec. 21, 1902	Sept. 30, 1904
J. O. Wright	10 barges	$4,000	do	Oct. 31, 1902	Mar. 8, 1905
R. T. Clark	202,100 cubic yards levee work. 97,500 cubic yards levee work. 109,000 cubic yards levee work. 34,000 cubic yards levee work.	12.72 cents. 13.95 cents. 18.45 cents. 24.87 cents.	Apr. 11, 1903	Mar. 9, 1903	(a)
Bobbitt & Linnan	379,900 cubic yards levee work.	24.74 cents	Aug. 24, 1903	July 23, 1904	Aug. 1, 1904
C. H. Whipple	75,000 cubic yards levee work. 39,000 cubic yards levee work.	19.5 cents 15.5 cents	Oct. 2, 1903	Apr. 1, 1904	Nov. 30, 1904
Chas. P. Willard & Co.	Stern-wheel steamboat	$11,120	Dec. 1, 1903	Dec. 11, 1903	(a)
M. L. Linnan	96,000 cubic yards levee work.	21.74 cents	Feb. 5, 1904	Jan. 11, 1904	Oct. 27, 1904
Wm. Wirt Johnston	4 barges	$4,400	Feb. 18, 1904	Feb. 28, 1904	Aug. 8, 1904
Menzies & Co	133,500 cubic yards levee work. 66,900 cubic yards levee work.	12.95 cents. 13.25 cents.	Mar. 11, 1904	Feb. 1, 1904	Dec. 9, 1904
Jordan Bros	23,500 cubic yards levee work.	12.98 cents	July 19, 1904	July 18, 1904	Sept. 6, 1904
Menzies & Co	125,300 cubic yards levee work.	12 cents	July 23, 1904	July 1, 1904	Nov. 5, 1904
M. L. Linnan	298,500 cubic yards levee work.	13.97 cents	do	Aug. 1, 1904	(a)
A. Mackie Grocery Co.	Groceries ($4,779.27)	Various	Emergency	July 25, 1904	Oct. 25, 1904
E. A. Enochs	687,100 feet B. M. lumber.	$11.50 per M.	do	July 28, 1904	Dec. 30, 1904
L. Mouledous	Vegetables ($702.90)	Various	do	July 28, 1904	Oct. 28, 1904
R. T. Clark	42,300 cubic yards levee work.	16.97 cents	Aug. 8, 1904	July 2, 1904	Mar. 15, 1905
R. S. Cade	Fresh meats ($2,799.75)	Various	Emergency	Aug. 10, 1904	Nov. 10, 1904
Standard Oil Co	3,600 gallons oil ($382)	do	do	Aug. 12, 1904	Mar. 12, 1905
B. R. Miller	Furnishing teams	$3.75 per day	do	Aug. 15, 1904	Dec. 27, 1904
J. J. Ball & Co	8,000 tons rock	$1.95	Aug. 23, 1904	Sept. 1, 1904	Jan. 6, 1905
G. H. A. Thomas Co	235,100 feet B. M. lumber.	$10.39 per M.	Emergency	Sept. 15, 1904	Oct. 31, 1904
Geo. H. Conrad	29,300 cubic yards levee work.	17.40 cents	Sept. 28, 1904	Oct. 10, 1904	Feb. 10, 1905
Wm. Wirt Johnston	2 barges	$4.400	Oct. 5, 1904	Oct. 17, 1904	Dec. 22, 1904
Jas. A. Cleary	26,600 cubic yards levee work.	17 cents	Oct. 6, 1904	Oct. 20, 1904	Dec. 27, 1904
Jordan Bros	60,500 cubic yards levee work. 34,500 cubic yards levee work.	11.88 cents. 11.75 cents.	Oct. 8, 1904	Oct. 22, 1904	Feb. 27, 1905
Menzies & Co	275,300 cubic yards levee work.	14.40 cents	do	Oct. 20, 1904	(a)
Geo. H. Conrad	16,000 cubic yards levee work.	23 cents	Oct. 13, 1904	Oct. 27, 1904	Jan. 6, 1905
Jas. R. Marlow	61,500 cubic yards levee work.	11.97 cents	Oct. 21, 1904	Nov. 5, 1904	Dec. 7, 1904
Benj. W. Borne	38,000 cubic yards levee work. 14,100 cubic yards levee work.	18.49 cents. 20 cents.	do	do	Mar. 14, 1905
Joseph Hingle	82,300 cubic yards levee work.	15¼ cents	Oct. 24, 1904	Nov. 8, 1904	Dec. 20, 1904
Jas. R. Marlow	52,100 cubic yards levee work. 23,500 cubic yards levee work.	21.97 cents. 19.90 cents.	do	do	(a)

a Time limit waived.

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Abstract of contracts in force during fiscal year ending June 30, 1905, fourth district, improving Mississippi River—Continued.

Name of contractor.	Amount and character of work.	Unit price.	Date of approval.	Date of beginning work.	Date of expiration of contract.
Woodward, Wight & Co.	Groceries ($5,004.50)	Various	Emergency	Oct. 26, 1904	Mar. 20, 1905
Geo. W. Davison & Co.	Vegetables ($141.54)	do	do	Oct. 28, 1904	Jan. 31, 1905
W. H. Pritchartt & Co.	Vegetables ($515.25)	do	do	do	Mar. 20, 1905
Natchez Dressed Beef Co.	Fresh meats ($1,511.08)	do	do	Nov. 11, 1904	Do.
Wm. Wirt Johnston	1 wooden decked hull	$4,100	Nov. 26, 1904	Dec. 29, 1904	Feb. 23, 1905
Hearin & Ryan	161,000 cubic yards levee work.	11.97 cents	Dec. 3, 1904	Dec. 19, 1904	(a)
E. A. Enochs	419,000 feet B. M. lumber	$13.50 per M.	Emergency	Aug. 1, 1905	Oct. 1, 1905
Salmen Brick and Lumber Co., Ltd.	652,000 feet B. M. lumber	$15.22+ per M. b	do	do	Oct. 20, 1905

a Time limit waived. b Average.

APPENDIX 4 B.

FOREIGN COMMERCE PORT OF NEW ORLEANS.

The statistics relating to the foreign commerce of the port of New Orleans were kindly furnished by Hon. Henry McCall, collector of customs.

Vessels.	Entrances.			Clearances.		
	1902–3.	1903–4.	1904–5.	1902–3.	1903–4.	1904–5.
Steam	1,287	1,173	1,351	1,278	1,167	1,375
Sail	87	71	60	79	64	46
Total	1,374	1,244	1,411	1,357	1,231	1,421

Total tonnage of above.

1902–3 a	4,792,547
1903–4 a	4,271,148
1904–5 a	5,034,684

Exports and imports.

	1903. a	1904. a	1905. a
EXPORTS.			
Total value of exports of foreign merchandise to foreign countries	$2,750,906	$595,106	$1,056,580
Total value of exports of domestic merchandise to foreign countries	146,668,388	150,174,251	144,272,357
Total value of exports of domestic merchandise to Porto Rico	2,473,791	3,465,982	3,337,280
Domestic specie exported to foreign countries	97,550	190,950	282,414
Total	151,985,635	154,336,289	148,948,631
IMPORTS.			
Total value of imports from foreign countries:			
Free	15,068,430	19,368,413	19,791,065
Dutiable	13,501,839	14,652,151	14,026,664
Transit to Mexico	1,702,084	1,836,042	1,698,989
Transported to interior ports	3,647,281	4,628,639	4,111,286
Specie	776,600	1,027,590	719,271
Total	34,696,234	41,512,835	40,347,225

a May 1 to May 1.

Total duties collected: In 1903, $8,954,781.79; 1904, $8,800,944.20; 1905, $6,695,664.29.

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APPENDIX 4 C.

REPORT OF MR. H. S. DOUGLAS, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *May 1, 1905.*

CAPTAIN: I have the honor to submit the following report relating to channel works in the fourth district, improving Mississippi River, from May 1, 1904, to May 1, 1905:

Bondurant revetment (644 R.).—The high water of 1904 caused practically no changes in the channel or works at this locality. The three cross sections at the head of the chute have been resounded, but no material changes were developed. Along the revetment the bank line is unchanged, and the work itself is generally in good condition, except the upper bank work placed in 1900–1901, which has been considerably injured by the excessive saturation of the bank caused by seepage from Lake Bruen. This has caused no apparent injury to the effectiveness of the work as a whole. The breaking up of one of the original board mattresses and a slight tendency of the current to eat into the bank line immediately above the revetment necessitated the replacing of the board mattress with one of standard construction, and a short extension of the revetment upstream, but beyond maintenance, this may be considered a finished and successful work. Immediately below the revetment the unprotected bank is receding at the rate of about 27 feet per year; but as the distance to the levee is 317 feet, no immediate extension of the work is indicated, even if the present rate of recession is maintained.

Kempe Bend revetment (657 R.).—The survey develops that along the revetment above section 15 there is still a low-water channel less than 40 feet deep. At section 1, near the head of the work, the 30-foot channel is but 40 feet wide, which gives a low-water area between 30-foot contours of only 1,200 square feet, whereas the low-water area between 30-foot contours, at section 3, near the lower end of the revetment, is 23,000 square feet, or twenty times as great. Such an abnormal condition of affairs would appear to be a menace to the integrity of the revetment, as a sudden shift of the gravel bar opposite may cause enormous and sudden scour at the shoal place and consequent destruction of work. Below section 15 the 50-foot contour is continuous, and the following changes in it from October, 1903, to September, 1904, are noted:

At section 12 there has been a fill causing an advance of 82 feet in the 50-foot contour. On sections 1, 4, 5, 7, 8, 9, 10, and 11 there has been a scour causing a recession of the contour of from 25 to 63 feet. At sections 10, 11, 12, and 13 there has been a fill in the channel along the outer edge of the mattress of from 10 to 20 feet, and at sections 1, 1½, 2, 3, 4, 7, and 8 there has been a scour of from 10 to 20 feet in the channel.

Upon the whole, with the exception of the recession of the 50-foot contour toward the bank, no unfavorable changes have been developed by the survey. There has been no failure of revetment in this bend since November, 1903, and the present outlook for the ultimate success of this work is encouraging.

Natchez and Vidalia harbors (Giles Bend) (689 L.).—The survey of November, 1904, develops but slight changes along the revetted bank when compared with the survey of November, 1903. The only marked change is the disappearance of the 50-foot contour at the lower end of the lower revetment. Of course the recession of bank line and contours along the unprotected portions of the bend has continued at the rate of about 100 feet per year. Some interesting comparisons can be made along the upper revetment by going back to the original survey of February, 1897, when the spur dikes were first placed, and comparing with the most recent survey. Originally the deepest continuous contour in front of the work was 50 feet, and for this reason the 50-foot contour will be used as a basis for comparison. In the table following is given the maximum recession of this contour toward the bank and the total scour in the channel during the eight years which have elapsed since the survey of 1897:

Location between spurs.	Recession of 50-foot contour.	Scour in channel.	Location between spurs.	Recession of 50-foot contour.	Scour in channel.
	Feet.	*Feet.*		*Feet.*	*Feet.*
Nos. 1 and 2	260	20	Nos. 8 and 9	85	30
Nos. 2 and 3	95	10	Nos. 9 and 10	105	20
Nos. 3 and 4	103	10	Nos. 10 and 11	115	40
Nos. 4 and 5	170	10	Nos. 11 and 12	90	40
Nos. 5 and 6	175	30	Nos. 12 and 13	110	30
Nos. 6 and 7	73	30	Nos. 13 and 14	95	20
Nos. 7 and 8	66	10	Nos. 14 and 15	220	30

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The major portion of the changes occurred prior to the placing of the continuous mattress work between the spurs, but the spur dikes themselves have withstood all of the scour shown in the table. The present conditions between spurs 1 and 2 and between spurs 5 and 6 are somewhat threatening, as the mattressed bank has now a slope of about 1 in 1.6, which on this portion of the river may be considered very unstable.

Construction.—During the past season bank-revetment work has been prosecuted at Bondurant, Kempe, and Giles bends, an aggregate of 1,333,950 square feet (30.6 acres), or 13,339.6 "squares," of framed mattress having been placed without accident or loss from any cause, for a total field cost of $80,175.83, or $6.01 per square. This is considerably less than the cost of similar work in the past. Compared with last season, when practically the same amount of mattress was placed, the principal economies were in material and labor used in building the mattresses, where a reduction of $4,422.51 was made, and in ballast and labor in sinking, whereby $2,111.49 was saved. Including superintendence, crew of boat, cutting and loading willow brush, and all auxiliary labor of every description necessary or incidental to the operation of the plant and construction of the mattress, it required an average daily force of 153 men for one hundred and eleven days to build 1,333,950 square feet of framed mattress, the average daily efficiency per man being 78 square feet. Comparisons of progress with other similar works where brush is obtained by contract can not be made, nor is it practicable in the instant case to separate the labor engaged in cutting and loading brush from that actually engaged in building the mattress.

Improving Atchafalaya and Red rivers, La.—During the year operations have been confined to the preservation and care of the dredging plant, to the maintenance of the low-water channel through lower Old River between the Mississippi and Red and Atchafalaya rivers, and to the annual survey of Old River and the Atchafalaya in the vicinity of the sill dams.

Details of work required for the care and preservation of the hydraulic dredge *The Ram* and auxiliary plant will be found in the report on plant.

On August 24 it was reported that there was but 7½ feet of water over the bar at the mouth of Old River. On this date the Barbres gauge read 11.2 and the Red River Landing gauge 11.4. Preparations to begin dredging were at once made, and on September 1 *The Ram* left the engineer depot with fuel barge, lighter, and pontons in tow. She arrived in Old River on September 5, and on that day soundings developed a least depth of 11 feet in the channel over the bar at the mouth, the Barbres gauge reading 11.5 and the Red River Landing gauge 13.1. Dredging was commenced on September 7 and was prosecuted until October 4, the total elapsed time being twenty-eight days, of which four were lost on account of Sundays and four while boats were passing, machinery being repaired, etc. During the twenty working days a channel about 6 feet below the zero of Barbres gauge, with a bottom width of about 100 feet and a total length of 2,100 feet, was dredged, the total amount of material moved being about 80,000 cubic yards. The work was successful, and, except for a short distance at the Mississippi end, where cross currents caused the dredged cut to fill, a depth of 5 feet and more below the zero of the Barbres gauge was maintained. At no time was navigation obstructed, although the Red River Landing gauge declined to 3 and the Barbres to 0.3. It was observed during the progress of the dredging that the material composing the bar contained a large proportion of gravel and that it was generally coarse sand. Actual dredging was suspended on October 4 but *The Ram* was kept in the vicinity, either laid up or engaged on other works, so that she would be immediately available should the bar again become shoal. Toward the end of January, 1905, it became evident that further dredging would be unnecessary and *The Ram* was returned to the engineer depot.

During the period from May 1, 1904, to May 1, 1905, there has been expended on this work the sum of $2,891.67, as follows:

Dredging in Old River	$1,960.60
Surveys	43.48
Care of plant	390.98
Repairs to plant	39.50
New plant	242.27
Miscellaneous	3.00
Administration and office expenses	211.84
Total	2,891.67

A hydrographic survey has been made of Old River from the Mississippi to the head of the Atchafalaya, and of the sill dams and vicinity in the Atchafalaya. The results of the survey of Old River are given in the appended table. Comparisons of

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mean depth and section, at a plane 35 feet above the zero of the Barbres gauge, are as follows:

Year.	Mean section.	Mean depth.
	Sq. feet.	*Feet.*
1894	20,901	26.6
1904	22,182	31.6
Increase	1,281	5.0

From this it would appear that the annual increase in average section has amounted to 128 square feet and of average depth to 0.5 feet, both inconsiderable.

The survey over the bar at the Mississippi end of Old River shows that the distance between the 5-foot contour in Old River and the 5-foot contour in the Mississippi is becoming greater. This fact is also indicated by the length of channel that it was necessary to dredge during the past season. There is also a possibility that changes in the channel of the Mississippi may intensify the difficulty of maintaining low-water navigation at the mouth of Old River by placing it on the convex rather than on the concave bank. The 20-foot contour in the Mississippi River is now over 300 feet from low-water line at Carrs Point.

The survey over the sill dams and vicinity develops scour as compared with the survey of February, 1903. The flood of 1903 culminated in April, after the completion of the survey of that year, with a height of 50.6 on the Barbres gauge. Past history is that every extreme flood since the dams were completed has caused scour, which a succession of moderate floods fills and obliterates. It may also be noted that the survey of 1903 was made with the river at a high stage and rising rapidly, making it difficult to obtain correct soundings. With this in mind it is not considered that the scour developed by the recent survey is a matter of serious importance.

So far as is known at the close of this report the sills are in good condition, except the shore end of the apron mattress on the upper side of Sill Dam No. 3, which has been injured, as mentioned in last annual report. Repairs have not been made owing to lack of funds. The general condition of the channel through lower Old River has remained practically unchanged.

New Orleans Harbor (965 R. and L.).—No construction work has been undertaken this season owing to lack of funds. Operations have been confined to the annual survey over the works and vicinity.

As the current project for mattress work in the Carrollton Bend provides for covering the bank below the 60-foot contour with a continuous mattress, permitting the steep bank between the zero and 60-foot contour to gradually wear away until a slope considered sufficiently flat had been obtained, any evidence of scour or fill on this area would be of considerable interest.

A careful study of the results of the survey has been made. No marked changes in the contours from zero to 60 feet is apparent in comparing the surveys of 1903 and 1904. The results may be said to be negative, and the same remark will apply elsewhere throughout the harbor when comparing the surveys of 1903 and 1904. Going back one year and comparing 1902 and 1903 changes are noted, which would go to prove that extraordinary floods, such as that of 1903, are required to materially affect the bottom and banks of the river in this locality. There has been no considerable caving of the banks in the harbor during the past year, but the pile protection work placed along the third district reach has failed extensively.

Plant.—At date of last report the plant consisted of 47 large pieces. During the year it has been reduced four pieces, old and worn-out barges *Nos. 6, 7, 19,* and *26* having been inspected, condemned, and sold. It has been increased by eleven new standard gunwale barges of creosoted timber, *Nos. 5, 6, 7, 9, 36, 37, 38, 39, 40, 41,* and *42,* a net gain of 7 pieces. All of these were built under contract.

The new steel-hull steamer *Tensas,* mentioned in last annual report, was reported finished by the contractors at Winthrop Harbor, on Lake Michigan, in October, 1904, and started for New Orleans, the place of delivery, via Green Bay and the Wisconsin and Mississippi rivers. She was overtaken by ice and found serious obstacles in the Wisconsin River. As a result the boat has not yet been delivered.

Repairs.—The work of caring for, maintaining, and repairing the plant of the district has been carried on at the new engineer depot, Hillary and Millaudon streets, New Orleans, La. The following work was done:

Steamer Genl. John Newton.—An entire new wheel was built; boiler raised, moved aft, and, together with necessary connections, reinstalled; boiler was extensively

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repaired, fitted with steam dome, new breeching, ash pan, and furnace; boat was painted throughout and current repairs made. Cost, $1,743.40.

Tug Genl. Gillespie.—Usual annual repairs to machinery to make good wear and tear; current repairs and painting. Cost, $410.03.

Tug Genl. Humphreys.—Boat docked and loose wheel refastened; annual repairs to machinery and hull to make good wear and tear; current repairs and painting. Cost, $423.12.

Tug Genl Abbot.—New steam capstan installed; new set tubes in condenser; boat docked and loose wheel refastened; bent rudder stock and shoe straightened; new furnace liners and grate bars; repairs to machinery and hull to make good annual wear and tear; current repairs and painting. Cost, $1,116.62.

Tug Genl. Comstock.—Docked and hull recalked; new main crank shaft and new end on tail shaft; entire new balanced steel rudder and stock; repairs to machinery and hull to make good annual wear and tear; current repairs and painting. Cost, $763.33.

Hydraulic dredge The Ram.—Minor repairs to boilers, propelling wheel and rudders; maintenance. Cost, $189.89.

Hydraulic grader No. 5.—Old smokestack taken down and new one 50 feet high installed; current repairs and maintenance. Cost, $333.12.

Quarter boat New Orleans.—A new hull of creosoted timber was built and delivered under contract; the cabin was removed from old hull, installed on the new one and current repairs made. Cost, $5,677.52.

Quarter boat Alpha.—Current repairs. Cost, $72.

Quarter boat Beta.—New guards and miscellaneous repairs to hull; current repairs to cabin and roof. Cost, $281.22.

Quarter boat Gamma.—New guards; new roof; alterations to cabin; calking, miscellaneous repairs, and painting throughout. Cost, $1,063.26.

Quarter boat Delta.—New capstan installed; new ice box. Current repairs. Cost, $210.47.

Barge No. 1.—Deck repaired and sheathed; new rakes; calking and current repairs. Cost, $229.81.

Barge No. 3.—Rakes repaired; sides calked; painted. Cost, $110.70.

Barge No. 4.—Gunwales repaired; sides calked; painted. Cost, $41.50.

Barge No. 8.—Head block repaired; corner irons put on rakes; sides and rakes calked; current repairs. Cost, $112.99.

Barge No. 10.—Deck and rakes repaired; clamps put on gunwales and bulkhead; rakes and sides calked. Cost, $143.17.

Barge No. 11.—Docked; deck repaired; corner irons put on rakes. Clamps put on gunwales; new stanchions in hold; bottom, rakes and sides calked. Cost, $245.49.

Barge No. 12.—Current repairs. Cost, $13.50.

Barge No. 13.—Deck repaired; clamps put on gunwales and bulkheads. Current repairs. Cost, $148.78.

Barge No. 14.—Current repairs. Cost, $7.50.

Barge No. 15.—Docked; sides repaired and sheathed; new rakes; three new iron bolts installed; bottom, sides, and rakes calked; painted. Cost, $553.06.

Barge No. 16.—Current repairs. Cost, $41.76.

Barge No. 18.—Docked; bottom repaired. One new rake, and other repaired; bottom, sides and rakes calked; current repairs and painting. Cost, $412.26.

Barge No. 19.—Current repairs. Cost, $21.

Barge No. 21.—Sides, rakes and head blocks repaired and calked; current repairs and painting. Cost, $201.99.

Barge No. 23.—Rakes and sides calked; current repairs and painting. Cost, $53.95.

Barge No. 24.—Docked; rakes repaired; sides repaired and sheathed; deck beams repaired and stanchions put in hold; bottom, sides and rakes calked; current repairs. Cost, $583.26.

Barge No. 26.—Current repairs. Cost, $33.

Barge No. 27.—Rakes repaired; sides and rakes calked; painted; deck repaired and sheathed. Cost, $174.29.

Barge No. 28.—Deck, sides and rakes repaired; rakes and sides calked. Cost, $60.05.

Barge No. 29.—Deck repaired; clamps put on gunwales and bulkheads; current repairs. Cost, $108.83.

Barge No. 30.—Rakes and sides repaired and calked; painted. Cost, $147.65.

Barge No. 31.—Docked; deck, sides and rakes repaired; bottom, sides and rakes calked; painted. Cost, $'17.50.

Barge No. 32.—Rakes and sides calked; painted. Cost, $44.

Barge No. 33.—Current repairs. Cost, $6.

Barge No. 34.—Current repairs. Cost, $30.40.

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Warehouse barge.—Current repairs. Cost, $12.75.

Sectional dock.—Sections 2, 3 and 4 were docked; new deck on sections 3 and 4; new stanchions; trunks replanked; calked throughout; new valves; miscellaneous repairs and painting. Cost, $1,278.03.

Tug dock.—New sides; new timber heads; new end; gate repaired; new platform and walk way; sides and ends calked; current repairs and painting. Cost, $666.18.

Stern dock.—Current repairs. Cost, $55.50.

Pump boat.—Docked; bottom repaired; new floor; calked throughout; current repairs; painting. Cost, $212.98.

Current repairs.—Included under this head are the small jobs incident to the maintenance of the plant in general, and not chargeable to any particular piece. They amounted to $264.16.

Care of plant.—The cost of caring for the plant while not in use, including such items as watching, setting spars, putting out and taking in mooring lines, operating pump boat, salary of one boat's crew, general supervision, etc., amounted to $8,046.33.

Condition of plant.—Barges *Nos. 19, 20, 21, 22, 23, 24, 25,* and *27* are almost unserviceable. The balance of the plant is in good condition for another year's service.

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Capt. J. F. MCINDOE,
Corps of Engineers.

Comparative sections of Lower Old River at a stage of water 35 feet above the zero of Barbres gauge.

[For surveys of 1899 and 1900, see Annual Report, 1903–4.]

Section.	Area.			Width.		
	1894.	1903.	1904.	1894.	1903.	1904.
19	23,730	24,620	29,920	895	855	966
20	22,570	24,964	28,868	825	823	860
21	.....	22,415	29,050	.....	680	796
22	21,280	28,842	31,036	745	770	772
23	21,627	25,476	27,297	710	775	722
24	21,925	22,952	23,760	795	710	735
25	21,385	23,844	24,109	755	720	701
26	21,110	22,443	23,708	780	730	720
27	21,787	22,868	22,985	795	685	719
28	20,682	.....	.....	795	.....	.....
29	21,093	21,506	23,410	782	650	710
30	19,725	22,175	24,080	830	670	735
31	19,900	21,433	22,315	815	633	685
32	19,280	21,745	21,911	865	625	658
33	21,067	21,976	23,086	785	680	710
34	21,090	22,054	22,314	790	695	677
35	21,302	21,331	22,528	840	680	666
36	22,622	22,682	23,183	840	695	743
37	25,087	23,851	23,513	885	695	697
38	.....	23,791	23,968	.....	815	798
39	22,087	24,305	22,503	680	720	735
39½	21,382	.....	.....	675	.....	.....
40	24,925	21,597	23,967	615	660	782
41	19,772	21,057	23,635	680	685	743
42	19,632	22,235	25,122	680	750	794
43	18,707	21,565	22,590	655	650	656
44	18,395	20,917	22,197	655	655	650
44½	18,707	.....	.....	675	.....	.....
45	18,967	22,107	22,345	685	620	629
46	19,010	21,299	23,149	685	630	668
47	19,432	21,192	21,972	670	690	701
48	19,587	20,858	22,588	705	700	746
49	20,155	22,088	23,638	720	730	743
50	20,527	21,647	22,229	730	730	741
50½	20,322	.....	.....	770	.....	.....
51	21,237	21,782	21,782	860	725	719
52	21,027	23,485	22,038	805	750	761
53	20,254	22,097	21,401	755	705	711
54	20,910	22,095	21,498	755	705	719
54½	20,335	.....	.....	695	.....	.....
55	19,505	21,589	22,143	695	665	659
56	18,697	20,073	22,525	707	740	725
57	20,117	20,546	21,684	830	750	829
58	21,462	23,625	22,176	870	795	797
59	21,857	23,528	22,068	835	810	824
60	21,385	20,085	22,479	950	835	778

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Comparative sections of Lower Old River at a stage of water 35 feet above the zero of Barbres gauge—Continued.

Section.	Area.			Width.		
	1894.	1903.	1904.	1894.	1903.	1904.
61	22,085	23,066	22,707	855	810	807
62	21,197	21,974	21,506	980	820	650
63	20,667	20,868	20,371	910	825	741
63½	21,655			980		
64	20,690	21,341	21,510	900	680	684
65	22,152	20,866	20,690	890	720	691
66	21,022	19,499	20,435	830	680	677
67	21,587	20,080	21,417	835	770	680
68	21,377	20,934	20,137	960	765	729
68½	21,235			825		
69	22,007	20,784	20,195	860	765	690
70	20,977	21,691	20,675	855	740	734
71	23,795	20,973	21,619	840	730	758
72	20,277	20,475	21,300	725	700	729
72½	22,427			865		
73	22,367	20,232	20,973	890	675	727
74	21,240	20,027	21,089	940	770	765
75	20,115	20,533	21,350	775	625	744
76	20,447	20,568	20,678	755	640	698
77	20,072	20,668	20,014	710	595	610
77½	21,197			880		
78	21,855	20,625	21,055	705	610	606
79	21,335	21,208	21,151	730	600	603
80	20,520	20,399	20,766	980	605	611
81	20,417	21,380	21,195	900	620	641
82	21,112	20,825	20,751	905	625	608
83	20,905	20,166	20,698	800	585	575
84	20,710	20,089	19,996	725	580	568
85	21,105	20,666	20,887	770	610	599
86	21,685	20,317	21,592	830	575	587
87	19,992	20,917	22,335	730	705	742
88	20,072	20,861	22,671	695	695	685
89	20,117	21,086	22,847	705	675	665
90	20,342	21,222	21,324	695	635	620
90½	17,692			735		
91	21,290	21,210	21,752	725	645	685
92		23,068	21,551		780	737
92½			24,233			717
93		21,978	22,430		685	699
93½		22,027	22,460		715	727
94	23,992	22,540	22,985	995	670	757
95	23,747	21,757	22,984	1,060	790	831
96	21,175	20,871	22,175	885	705	705
97	22,960	20,610	21,053	975	620	650
98	22,477	19,789	21,340	875	740	649
99	22,685	20,965	21,523	875	740	636
100	22,565	20,245	21,252	860	670	628
101	21,450	22,945	20,371	845	830	580
102	21,165	22,887	21,814	770	740	707
103	21,107	22,873	23,161	820	740	712
104	21,835	22,322	22,007	775	750	747
105	21,002	22,196	22,310	795	800	729
106	21,220	22,701	22,340	830	760	759
107	20,760	22,817	22,382	825	785	715
108	21,875	20,922	22,544	850	730	727
109	21,732	22,268	22,056	850	725	734
110	20,397	21,253	20,812	825	730	734
111	19,859	21,614	21,016	810	715	712
112	20,102	22,059	20,596	770	695	700
113	20,670	21,561	20,287	880	740	696
114	20,577	22,366	21,225	765	660	695
115	20,070	21,289	20,589	700	700	703
116	19,727	21,989	20,052	720	660	689
117		21,955	20,406		670	686
117½	19,975	22,406	19,992	750	690	684
119	19,345	21,223	20,507	700	695	694
120	19,787			750		
121	19,687	21,669	20,427	670	700	703
122	19,425	21,344	19,985	655	695	701
123	20,805			780		
124	20,787	20,787	19,742	800	690	664
125		21,792	19,206		670	656
126		22,348	18,939		625	590
127	19,840	21,673	20,005	680	615	633
128	18,470	21,815	20,080	600	590	603
129		27,691	31,075		680	711
Total	2,840,922	2,877,110	2,440,083	88,794	76,576	77,388
Average	20,901	21,509	22,182	798	708	708

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Comparative sections of Lower Old River at a stage of water 35 feet above the zero of Barbres gauge—Continued.

Section.	Maximum depth.			Mean depth.		
	1894.	1903.	1904.	1894.	1903.	1904.
19	40.0	57.7	58.4	26.5	28.8	30.9
20	40.0	52.6	57.9	27.4	30.3	33.5
21	.....	55.9	57.1	.....	32.9	36.5
22	40.0	58.8	58.7	28.5	37.5	40.2
23	41.0	48.6	52.8	30.4	32.9	37.8
24	40.0	46.0	47.9	27.6	32.3	32.3
25	43.0	44.8	44.8	28.3	33.1	34.3
26	43.0	46.3	44.3	27.1	30.7	32.9
27	42.0	44.3	44.0	27.4	33.4	31.9
28	40.0	.....	.....	26.0	.....	.....
29	44.0	46.0	46.6	26.9	33.1	32.9
30	45.0	47.2	49.8	23.8	33.1	32.6
31	45.0	48.2	51.8	24.5	33.9	32.5
32	41.0	49.3	54.0	22.3	34.7	33.3
33	44.0	49.6	55.6	26.8	32.3	32.4
34	44.0	49.5	53.6	26.7	31.7	32.9
35	42.0	49.2	54.7	25.4	31.7	33.8
36	46.0	48.1	53.7	26.9	32.6	31.1
37	51.0	48.6	52.8	28.3	33.3	33.8
38	.....	49.2	50.7	.....	29.2	30.2
39	55.0	47.0	48.3	32.4	33.7	30.6
39½	56.0	.....	.....	31.7	.....	.....
40	52.0	49.4	51.4	40.5	32.7	32.7
41	44.0	54.0	57.0	29.1	30.7	31.8
42	44.0	49.8	50.4	28.9	29.6	31.6
43	44.0	53.7	57.4	28.5	33.2	34.4
44	44.0	52.7	60.5	27.7	31.9	34.1
44½	47.0	.....	.....	27.7	.....	.....
45	44.0	50.5	62.0	27.7	35.6	35.5
46	45.0	47.4	56.6	27.8	33.8	34.9
47	45.0	46.5	47.6	29.0	30.7	31.3
48	45.0	45.8	46.6	27.8	29.8	30.2
49	44.0	47.2	47.1	28.0	30.2	31.8
50	45.0	46.4	47.8	28.1	29.6	30.0
50½	44.0	.....	.....	26.4	.....	.....
51	46.0	46.9	49.4	24.7	30.0	30.3
52	44.0	46.8	49.9	26.1	31.3	28.9
53	44.0	46.5	49.1	26.8	31.3	30.1
54	44.0	47.1	49.6	27.7	31.1	29.8
54½	44.0	.....	.....	29.3	.....	.....
55	42.0	46.3	50.7	28.1	32.4	33.6
56	42.0	46.6	48.3	26.8	27.1	31.1
57	43.0	47.3	48.6	24.2	28.1	26.1
58	44.0	47.2	46.7	24.6	29.7	27.7
59	42.0	46.1	47.5	26.2	29.0	28.8
60	46.0	46.4	47.8	22.5	24.0	28.8
61	43.0	44.6	48.2	25.7	28.5	28.1
62	43.0	47.9	46.6	22.8	26.8	33.1
63	46.0	48.0	49.4	22.7	24.7	27.4
63½	46.0	.....	.....	33.8	.....	.....
64	39.0	47.2	46.5	28.0	31.2	31.4
65	40.0	50.2	50.3	24.9	28.9	29.9
66	42.0	50.3	50.5	25.3	28.7	30.2
67	44.0	49.8	53.4	25.9	26.0	31.4
68	46.0	50.8	55.7	22.2	27.4	28.0
68½	45.0	.....	.....	25.5	.....	.....
69	45.0	47.8	49.4	25.6	27.2	29.2
70	46.0	47.9	47.9	24.5	29.3	28.2
71	43.0	47.6	51.6	28.2	28.7	28.5
72	46.0	47.0	47.1	28.0	29.2	29.2
72½	48.0	.....	.....	25.9	.....	.....
73	46.0	26.1	47.3	25.1	30.0	28.8
74	47.0	47.1	46.5	22.6	26.0	26.8
75	44.0	47.2	44.5	25.9	32.7	28.7
76	47.0	46.6	44.0	27.1	32.1	29.5
77	55.0	49.4	51.3	28.3	34.8	32.8
77½	44.0	.....	.....	25.5	.....	.....
78	58.0	51.9	52.2	29.2	33.7	36.3
79	56.0	50.6	50.4	26.5	35.3	35.1
80	58.0	53.8	51.9	22.1	35.7	33.9
81	55.0	55.4	58.9	22.5	34.4	33.1
82	57.0	54.3	55.4	23.3	33.3	34.1
83	57.0	53.3	56.8	26.1	34.4	35.9
84	60.0	53.4	55.6	28.5	34.6	35.2
85	59.0	58.9	55.6	27.3	33.8	34.9
86	50.0	53.5	59.3	23.7	35.3	36.7
87	47.0	52.4	57.2	27.0	29.6	30.1
88	48.0	51.0	55.7	28.8	30.0	33.1

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Comparative sections of Lower Old River at a stage of water 35 feet above the zero of Barbres gauge—Continued.

Section.	Maximum depth.			Mean depth.		
	1894.	1903.	1904.	1894.	1903.	1904.
89	49.0	48.7	52.2	28.5	31.2	34.3
90	50.0	50.0	58.4	29.3	33.4	34.4
90½	47.0	.....	.....	24.1	.....	.....
91	54.0	48.4	52.6	29.3	32.9	34.2
92	.....	52.9	53.9	.....	29.4	29.2
92½	.....	.....	52.6	.....	.....	33.6
93	.....	48.2	49.4	.....	32.1	32.1
93½	.....	47.9	50.3	.....	30.8	30.9
94	48.0	48.9	51.3	24.0	29.2	30.3
95	43.0	46.4	51.6	22.4	27.5	27.6
96	42.0	48.3	51.4	22.1	29.6	31.4
97	46.0	47.8	51.7	23.5	33.2	32.3
98	51.0	50.8	53.0	25.7	26.7	32.8
99	50.0	51.3	52.5	25.6	29.9	33.8
100	75.0	50.7	55.7	26.2	30.2	33.8
101	48.0	52.1	55.6	26.5	27.6	35.1
102	48.0	52.9	58.9	27.5	30.9	30.8
103	48.0	50.2	53.2	25.7	30.2	32.5
104	48.0	48.1	52.4	28.3	29.7	29.4
105	44.0	48.2	50.4	26.4	27.7	30.6
106	47.0	48.0	50.6	25.6	29.8	29.4
107	46.0	47.4	49.4	25.2	31.0	31.2
108	46.0	46.0	49.3	25.7	28.6	31.0
109	47.0	44.7	44.4	25.6	30.7	30.3
110	48.0	46.0	46.4	24.7	29.1	28.3
111	48.0	46.2	49.0	24.5	30.2	29.5
112	50.0	46.6	44.2	26.1	31.8	29.4
113	48.0	45.9	44.0	24.9	29.1	29.1
114	48.0	46.4	44.0	26.9	33.9	31.9
115	49.0	44.2	43.2	28.7	30.3	29.2
116	46.0	47.9	43.4	27.4	33.2	29.1
117	.....	45.3	45.5	.....	32.8	29.7
117½	46.0	44.1	43.3	26.6	32.5	29.2
119	46.0	43.1	41.9	27.6	30.5	29.5
120	46.0	.....	.....	26.3	.....	.....
121	45.0	42.5	40.9	29.4	30.9	29.1
122	47.0	43.5	41.2	29.6	30.7	29.4
123	50.0	.....	.....	26.7	.....	.....
124	52.0	44.5	41.7	25.9	30.0	29.7
125	.....	49.3	41.4	.....	32.5	29.2
126	.....	50.8	42.3	.....	35.7	32.1
127	48.0	52.5	47.0	31.5	35.2	31.6
128	52.0	54.2	50.9	30.8	36.9	33.3
129	.....	77.7	78.9	.....	40.7	43.6
Total	5,246.0	5,344.9	5,567.7	2,977.1	3,401.6	3,481.6
Average	46.8	49.0	50.6	26.6	31.2	31.6

APPENDIX 4 D.

REPORT OF MR. E. B. GEDDES, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *May 1, 1905.*

SIR: I have the honor to submit the following report of operations at Bondurant Chute, Kempe Bend, and Giles Bend from May 1, 1904, to May 1, 1905:

BONDURANT CHUTE.

The total length of revetment in Bondurant Chute at date of last report was 2,295 feet. The work was in good condition, with the exception of a part of the concrete-in-situ pavement, which had been more or less damaged by seepage from Lake Bruen. The sand bank at times is converted into a semifluid mass by the excessive seepage, causing the breaking up and sinking of the pavement.

The last high water scoured away the bank above the mattress sunk on the salient point the previous season, and one of the board mattresses just above the point was wrecked by the subsidence of the bank, and there were indications of the usual pocket forming above the upper end of the revetment.

The work projected for the past season was to extend the revetment about 145 feet upstream to protect work in place, to cover over the wrecked board mattress with a willow mattress, and protect the bank on the salient point from further scour. All the work planned for the season was successfully completed.

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Bondurant Chute is only accessible to the tugs required for placing the mattresses when the river is above a 26-foot stage at Vicksburg.

Mattress construction was carried on for this work in connection with that for Kempe Bend, at Bruinsburg bar, on the opposite side of the river from the head of the chute. The mattresses were commenced December 12 and completed December 15, and were built on the bar so as to float off when the river had reached about a 26-foot stage at Vicksburg.

By March 6 it had become evident that a stage of water would be reached that would permit of the tugs with the plant required for placing the mattresses to get into the chute at the lower end. Preparations were therefore made to place the mattresses, and the plant was moved into the chute March 7 and 8, and the work completed by March 14. The plant was returned to Kempe Bend March 15.

The detailed cost of the work is given below, except mattress construction, which is reported elsewhere. Mattress construction, 34,500 square feet, $1,031.55.

Towing.—As the mattresses were built on the bar within about 2 miles of where they were sunk, the cost of towing is too small to be considered.

Sinking.—No difficulty was experienced in sinking the mattresses. A mattress 130 by 150 feet was sunk at the upper end of the revetment, and a mattress 100 by 150 feet was sunk over the wrecked board mattress. The concrete ballast used for sinking the Bondurant mats was loaded from the gravel bar near Kempe Bend and cost $1 per ton to load.

Tugs	$381.00
284 tons of concrete, at $1	284.00
Provisions	71.40
Pay rolls	235.32
Total	971.72

Square feet of mattress sunk, 34,500; cost per square foot to sink, $0.0281.

Cost of mattress in place.—

Construction, per square foot	$0.0299
Sinking, per square foot	.0281
Total cost per square foot in place	.0580

Paving upper bank.—The salient point above the mattress sunk last season was protected for a length of about 50 feet by concrete blocks left over from the sinking. Cost, $72.50.

Installation.—This item includes a part of the expenses of towing the plant from the engineer depot at New Orleans to the different works and returning it again, also certain fixed expenses for care of plant at Kempe Bend while waiting for sufficient water to enter the chute. Cost, $225.

Surveys.—The three cross sections laid off at the head of the chute last season, to determine whether the chute was filling up, were resounded and the bank line below the revetment located for some distance. Cost, $60.34.

Cost.—The total disbursements for this work from May 1, 1904, to May 1, 1905, amounted to $3,000, distributed as follows:

Construction of mattresses	$1,031.55
Sinking of mattresses	971.72
Paving upper bank	72.50
Installation	225.00
Surveys	60.34
Care of plant	92.00
Office expenses and administration	546.89
Total gross cost	3,000.00
Deduct last two items	638.89
Total net cost	2,361.11

Summary.—

Mattress sunk	square feet	34,500
Bank graded and paved	do	1,400
Bank mattressed	linear feet	150
Extension to revetment	do	145
Total revetment in Bondurant Chute	do	2,440

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The revetment in Bondurant Chute is now continuous for a length of 2,440 feet. A comparison of the soundings over the sections laid off at the head of the chute shows that no general filling up at the head of the chute has taken place in the last year, and it is believed that a further extension of the revetment downstream will be necessary in a year or two to protect the angle of the present levee line.

KEMPE BEND.

The total length of revetment in Kempe Bend at date of last report was 7,593 feet. There were three detached pieces of revetment—Upper Kempe 883 feet, Middle Kempe 1,395 feet, and Lower Kempe 5,315 feet long—the two gaps of unprotected bank between being 2,718 feet.

The work proposed for the past season was as follows: To close the two gaps in the revetment with a mattress 250 feet wide, to repair existing work, and to protect the upper bank up to a 20-foot stage as far as available funds would permit.

As a result of the season's work the two gaps between the three pieces of revetment, which on account of the mattresses at the ends having been wrecked required 2,885 linear feet, were closed with a mattress 250 feet wide, making the revetment continuous for 10,311 feet; the mattresses placed the previous season to protect the upper end of the Starling loop, the inner edge of which had been more or less wrecked and pushed out into the river by the subsiding bank, were brought up to about average low water by strips of mattresses wide enough to lap well over the old work; minor repairs were made to the upper bank work at the lower end of the revetment; a number of ditches were cut to drain water in borrow pits out into the river, and the bank at the upper end was graded for a length of 2,700 feet and paved for a length of 865 feet.

Operations were commenced August 12, 1904, when the quarter boat *Delta* was moved to Racehorse Island. The quarter boat *Gamma* assisted on mattress construction from August 23 until September 5, when the small force on the *Gamma* was moved to Kempe Bend and preparations made for sinking.

By September 19 it had become evident that a sufficient force of white laborers could not be secured at that time of the year to sink in Kempe Bend, and the force was moved to Giles Bend. After completing the sinking in Giles Bend the plant was returned to Kempe Bend November 6, and the first sinking made November 10 and the last regular sinking on December 29. Hydraulic grader *No. 5* was fitted out at the engineer depot and reached Kempe Bend January 3. Grading was continued until March 6, when all work was suspended in Kempe Bend on account of the high stage of the river. All the plant used on the works above Natchez was taken to New Orleans, the last tow arriving there on March 21, and laid up for the season.

Mattress construction.—All the mattresses used at Bondurant Chute, Kempe Bend, and Giles Bend were built at Racehorse Island, about 8 miles below Vicksburg, and at Bruinsburg bar, opposite the head of Bondurant Chute. No changes were made in the mattresses or methods of construction. Nearly all the mattresses were built by the force on the *Delta*, the *Gamma* assisting for fourteen days.

Operations were commenced at Racehorse Island August 12, and continued there until November 11, when the construction plant was moved to Bruinsburg bar. Operations were carried on at the latter bar until December 20, when 1,333,950 square feet had been completed for the different works, as follows:

	Square feet.
Bondurant Chute	34,500
Kempe Bend	838,650
Giles Bend	460,800
Total	1,333,950

The details of the cost are as follows:

Willow brush.—

Teams hauling	$6,854.07
Cutting, loading, etc	7,574.08
Privilege of land	267.07
Total	14,695.22

Total cords of willow brush, 14,219; cost per cord, delivered at the ways, $1.03.

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Construction.—

10,000 feet B. M. miscellaneous lumber	$115.00
411,000 feet B. M. 2 by 4 inch lumber	5,203.45
266,292 feet B. M. 3 by 6 inch lumber	3,325.90
20,800 pounds 9-inch steel wire nails	416.00
42,300 pounds 6-inch steel wire nails	846.00
5,900 pounds 4-inch steel wire nails	118.00
7,930 pounds No. 10 galvanized wire	157.57
14,219 cords of willow brush	14,695.22
80,000 tree nails	144.10
Steamers and tugs	1,230.00
Miscellaneous	100.16
Provisions	2,847.15
Pay rolls	10,675.80
Total	39,874.35

Total square feet of mattresses built, 1,333,950; cost per square foot at ways, $0.0299.

Towing mattresses.—The distance from Racehorse Island to Kempe Bend is about 60 miles by river and from Bruinsburg bar 15 miles, and the cost of towing the 838,650 square feet of mattresses was:

Tug *General Abbot*, 12 days, at $23	$276.00
Tug *General Humphreys*, 27 days, at $25	675.00
Tug *General Comstock*, 4 days, at $21	84.00
Dredge *The Ram*, 13 days, at $33	429.00
Total	1,464.00

Square feet mattress towed, 838,650; cost per square foot for towing, $0.0017.

Sinking.—The delays occasioned by inability to secure white labor early in the season to do the sinking, which made it necessary to move the sinking plant to Giles Bend and return to Kempe later on, increased the cost of this work to a very considerable extent.

Three thousand and thirty-one tons of the rock used for ballasting the mattresses were obtained from New Orleans and delivered at Kempe Bend for $1.95 per ton. The balance of the rock used was delivered on barges at Vidalia for $1.95 per ton.

The towing of the Vidalia rock cost 14 cents per ton, making the cost of the rock in Kempe Bend $2.09.

It was required to place a mattress in the gaps between the pieces of revetment 250 feet wide, and as the current in Kempe Bend is very swift the mattresses were made in sections of 100 by 120 feet and 50 by 120 feet so that they could be placed by the three tugs in position for sinking. A total of 838,650 square feet was sunk, which includes 102,000 square feet of connecting mattresses that were used for making the junction with the pavement and for bringing the mattresses of the middle revetment up to low-water mark.

Steamers and tugs	$5,596.00
Lumber, wire, wire nails, etc	548.00
2,351 tons of rock, at $2.09	4,913.59
3,031 tons of rock, at $1.95	5,910.45
Miscellaneous	136.00
Provisions	2,074.20
Pay rolls	6,677.00
Total	25,855.24

Cost of mattresses in place—

Construction of mattresses	$0.0299
Towing of mattresses	.0017
Sinking of mattresses	.0308
Cost per square foot in place	.0624

Grading.—The grading was done with hydraulic grader *No. 5*, operating two jets most of the time. The bank was dressed by hand. The material along this stretch is a very stiff buckshot clay and full of stumps, and this increased the cost. Owing to the high stage of the river at the close of the work part of the bank will have to be gone over again to bring it to the required slope.

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Tugs	$408
Coal, oil, etc	440
Provisions	864
Pay rolls	2,160
Total	3,872

Linear feet of bank graded, 2,700; cost per linear foot for grading, $1.43.

Paving upper bank.—Vidalia rock was used for paving with about a 2-inch layer of coarse gravel underneath. The work was interrupted from time to time by the fluctuations of the river, which increased the cost to some extent.

Tugs	$156.00
1,180 tons of rock, at $2.09	2,466.20
153 tons of concrete blocks, at $1	153.00
Provisions	214.76
Pay rolls	505.82
Total	3,495.78

Square feet paved, 32,600; cost per square foot, $0.1072.

Repairs to old pavement.—Some repairs were made to the 2,000 linear feet of pavement at the lower end of the revetment that still remains intact. The cost, including tugs and incidentals, was $605.80.

Draining borrow pits.—Ditches were cut where needed to drain the rain water out of the borrow pits along the levee into the river. Cost, $494.05.

Clearing and felling timber.—Cutting the trees above and below the revetment that might cave into the river and form obstructions to future work, and clearing 2,700 linear feet of bank of trees and logs for the grader. Cost, $318.93.

Installation.—The installation expenses for Kempe Bend this season were unusually high for the amount of work done, owing to the delay in securing a sufficient force to operate the sinking. This made it necessary to move to Giles Bend and return later on to finish the work at Kempe. Cost, $3,027.02.

Surveys.—A complete hydrographic survey of the entire bend was made, in addition to the usual survey work for locating the mattresses and platting the field charts. The cost, including tugs and incidentals, was $1,083.24.

The total cost of the work in Kempe Bend from May, 1, 1904, to May 1, 1905, was $77,293.23, distributed as follows:

Construction of mattresses	$25,064.88
Towing of mattresses	1,464.00
Sinking of mattresses	25,855.24
Grading upper bank	3,872.00
Paving upper bank	3,495.78
Repairs to upper bank pavement	605.80
Clearing bank and felling timber	318.93
Draining borrow pits	494.05
Installation	3,027.02
Surveys	1,083.24
Miscellaneous	30.48
Repairs to plant	963.73
Care of plant	4,029.98
New plant	930.50
Office expenses and administration	6,057.60
Total gross cost	77,293.23
Add value of material now on hand, which was paid for out of this appropriation	3,693.00
Total amount expended	80,986.23

From the gross cost, $77,293.23, deduct "repairs to plant," "care of plant," "new plant," and "office expenses and administration," and the remainder, $65,311.42, is the net or field cost of the work.

Summary.—

Mattress sunk	square feet	838,650
Bank paved	do	32,600
Pavement repaired	do	9,000

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Bank mattressed	linear feet	2,885
Extension of revetment	do	2,718
Ditches dug	do	3,200
Bank graded	do	2,700
Bank paved	do	865
Timber felled	acres	12
Total revetment in Kempe Bend	linear feet	10,311

The subaqueous revetment in Kempe Bend is now continuous for a length of 10,311 feet, and protects all of the immediately threatened part of the levee line.

GILES BEND.

The total length of revetment in Giles Bend at date of last report was 14,571 feet (corrected measurement).

There were three detached pieces of revetment—Upper Giles 7,586 feet, Middle Giles 313 feet, and Lower Giles 6,672 feet long—all of which were in fairly good condition.

As the bank still continues to cave along the unprotected part of the bend at the rate of about 100 feet per year, the usual pockets had formed at the ends of the different pieces of revetment, which threatened to destroy some of the work already in place.

The work projected for the season just closed was as follows: To extend Upper Giles 485 feet upstream and 121 feet downstream, with a mattress 300 feet wide; to extend Middle Giles 265 feet upstream and 115 feet downstream; to extend Lower Giles 351 feet upstream; to make miscellaneous repairs to 14,571 linear feet of revetment, and grade and pave about 600 linear feet of bank near section 27, which had been graded back by the water to nearly the required slope. All of the work planned for the season was successfully completed.

The mattresses for this work were built at Racehorse Island and towed to Giles Bend.

It had been the intention to complete the sinking in Kempe Bend before moving the sinking plant to Giles Bend, but on account of not being able to secure a sufficient force of white labor on the *Gamma* to handle the difficult work at Kempe it was decided to move the plant to Giles Bend, where the conditions for sinking were more favorable, and where it was thought colored labor could be procured, without subsistence, from the surrounding plantations.

The quarter boat *Gamma* was therefore moved from Kempe Bend to Giles Bend on September 20, and the first mattress sunk September 23 and the last sinking made October 31. By November 6 a sufficient white force had been accumulated on the *Gamma* to handle the sinking in Kempe Bend, and the work in Giles was suspended and all the plant returned to Kempe Bend.

On December 22 the force on the quarter boat *Delta* having completed all the mattresses required for the different works, the *Delta* and other plant engaged on mattress construction were moved to Giles Bend and the repair work on the spurs and paving at section 27 completed by January 12.

The detailed cost of the work is given below, except mattress construction, which is reported elsewhere:

Mattress construction.—Four hundred and sixty thousand eight hundred square feet. Cost, $13,777.92.

Towing.—The mattresses used at Giles Bend were built at Racehorse Island and towed to Giles Bend, a distance of about 90 miles.

Tug *Genl. Gillespie*, 10 days, at $26	$260
Tug *Genl. Humphreys*, 14 days, at $25	350
Tug *Genl. Abbot*, 10 days, at $23	230
Tug *Genl. Comstock*, 4 days, at $21	84
Total	924

Square feet of mattress towed, 460,800; cost per square foot for towing, $0.0020.

Sinking.—To extend the revetment 1,337 feet it was necessary to mattress 1,427 linear feet of bank about 300 feet wide. This required 399,565 square feet, and 61,235 square feet were required for repair work around spurs 4, 6, 9, and 14, and for making junction with pavement at section 27, where a small cave had occurred. The work early in the season was very much hampered for want of efficient labor. White

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labor could not be procured at all, and the work had to be carried on mostly with such negro labor as could be procured, without subsistence, from the surrounding country.

Steamers and tugs	$1,504.00
Lumber, wire, wire nails, etc.	176.00
2,856 tons of rock, at $2.09	5,969.04
Miscellaneous	68.65
Provisions	821.60
Pay rolls	2,547.23
Total	11,086.52

Square feet of mattress sunk, 460,800; cost per square foot to sink, $0.0240.

Cost of mattress in place.—

Construction of mattresses	$0.0299
Towing of mattresses	.0020
Sinking of mattresses	.0240
Total cost per square foot	.0559

Grading and paving upper bank.—The 600 linear feet of bank at section 27 was graded and paved with rock up to about a two-thirds stage. The cost, including tugs and incidentals, was $4,379.26.

Repairs to pavement.—Repairs were made to the pavement at spurs 2, 3, 4, 5, 6, 7, 8, 9, 10, and 14, and breaks in the concrete-in-situ pavement at the lower end of the bend were filled up and repaved with rock and concrete blocks. The cost, including tugs and incidentals, was $1,828.27.

Timber felling.—The timber along the unprotected part of the bend was felled for a width of about 150 feet to prevent caving into the river and forming obstructions to future work. Cost, $213.88.

Installation.—The proportion of installation expenses charged to this work is $1,303.82.

Surveys.—A complete hydrographic survey of the entire bend was made between September 17 and November 25, 1904, in addition to the usual survey work for locating the mattresses and platting the field charts. The cost, including tugs and incidentals, was $1,146.37.

Cost.—The total disbursements on account of this work from May 1, 1904, to May 1, 1905, were $40,139.62, divided as follows:

Construction of mattresses	$13,777.92
Towing of mattresses	924.00
Sinking of mattresses	11,086.52
Grading and paving upper bank	4,379.26
Repairs to pavement	1,828.27
Timber felling	213.88
Installation	1,303.83
Surveys	1,146.37
Miscellaneous	22.02
Repairs to plant	461.44
Care of plant	630.67
New plant	386.31
Office expenses and administration	3,979.13
Total gross cost	40,139.62
Deduct last four items	5,457.55
Total net or field cost	34,682.07

Summary—

Mattress sunk	square feet	460,800
Bank graded and paved	do	34,653
Pavement repaved	do	28,376
Bank mattressed	linear feet	1,427
Extension to revetment	do	1,337
Timber felled	acres	14
Total revetment in Giles Bend	linear feet	15,908

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The total length of the three pieces of revetment in Giles Bend is now 15,908 feet, as follows:

	Feet.
Upper Giles	8,192
Middle Giles	693
Lower Giles	7,023

Caving still continues along the unprotected part of the bend and considerable scour has taken place along the outer edge of the mattresses at the upper end of the bend.

Very respectfully, your obedient servant,

E. B. GEDDES,
Assistant Engineer.

Capt. J. F. McINDOE,
Corps of Engineers.

APPENDIX 4 E.

REPORT OF MR. W. E. KNOBLOCH, SUPERINTENDENT OF LEVEES.

NEW ORLEANS, LA., *May 1, 1905.*

CAPTAIN: I have the honor to submit the following report on the levee work that has been done in the Lower Tensas, Atchafalaya, Lafourche, Barataria, Pontchartrain, and Lake Borgne districts from May 1, 1904, to May 1, 1905.

Construction.—During the past year construction forces were employed almost continuously in one or more of the districts.

In the Lafourche and Pontchartrain districts the greater amount of work was done by machinery, to which is attributed the comparatively lower prices paid for work in these districts.

Muck or base ditches.—Where an embankment to be enlarged was known to be leaky, and where conditions suggested that objectionable matter might be hidden under the foundation of a new levee, a muck or base ditch was cut within the base or at the toe of river slope of levee. There were but few cases of this character.

Surveys.—During the year an azimuth survey was made of the levee system in the Barataria and Lake Borgne districts. Crown levels and cross sections of the levee were taken. Topography was taken showing the location of houses, fences, ditches, etc., which might at some future time be within or near the base of a new levee. Bench marks were established at intervals of about 1,500 feet, and azimuth stations were marked with monuments.

Supervision.—No change has been made in the method of supervision as has been previously reported.

Protection against high water.—Up to the date of this report the water has barely gotten out of the banks and no protection work has been necessary.

Repairs.—In the Barataria and Lake Borgne districts a strong growth of weeds upon the levee prevents the spreading of the grass, and also by its shade keeps the embankment soft. During the summer these weeds were removed, either by contract or hired labor.

In the Pontchartrain district the borrow pits were drained and cleared in such places where during the coming year the levee was expected to be enlarged.

LOWER TENSAS LEVEE DISTRICT.

The only construction work done in this district was the completion of sections 4 and 5 of White Oak Lake, Lot 2, levee, which remained uncompleted at date of last annual report.

By resolution of the Mississippi River Commission, March 17, 1904, the expenditure of the money allotted to this district for the fiscal year 1905 was deferred.

The building of a new levee by the State authorities at each of the following places, Greens (721 R.) and Fish Pond (723 R.), has caused the abandonment of 14 571 linear feet of levee, embracing 316,122 cubic yards.

Of the 142.76 miles of effective levee now in this district there are on May 1, 1905, 494,003 linear feet, or 93.56 miles, built wholly or in part by the United States.

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ATCHAFALAYA LEVEE DISTRICT.

The construction of a new levee by the State authorities at each of the following places, Eliza (843 R.), Sardine Point (843.5 R.), Comeaux (845 R.), Australia (846 R.), Bayou Goula (866 R.), and Cora (870 R.), has caused the abandonment of 13,160 linear feet of levee, embracing 400,200 cubic yards.

Of the 128.46 miles of effective levee in this district there are on May 1, 1905, 441,059 linear feet, or 84.14 miles, built wholly or in part by the United States.

LAFOURCHE LEVEE DISTRICT.

The only construction work done in this district was the enlargement of part of the existing levee.

Of the 82.16 miles of effective levee in this district on May 1, 1905, there are 335,814 linear feet, or 63.60 miles, built wholly or in part by the United States.

BARATARIA LEVEE DISTRICT.

All work has been completed in this district and there now remain no contracts in force.

The construction of a new levee by the State authorities at each of the following places, Point Celeste (1010 R.), Rigaud (1021 R.), and Buras store (1038 R.), and by the United States at Alliance (1002 R.) and Point Michel (1020 R.), caused the abandonment of 10,543 linear feet of levee, embracing 61,470 cubic yards.

Of the 71.88 miles of effective levee in this district on May 1, 1905, there are 209,758 linear feet, or 39.73 miles, built wholly or in part by the United States.

PONTCHARTRAIN LEVEE DISTRICT.

Of the incomplete levees under contract at date of last report all have been completed except sections 1, 2, and 3 of Belmont levee (908 L.) and sections 1 and 2 of Hester levee (909 L.).

The construction of a new levee by the State authorities at each of the following places, Raum (899 L.) and Celestine (900 L.), and by the United States at Ophelia (866 L.) and Darrow (886 L.), has caused the abandonment of 10,481 linear feet of levee, embracing 127,097 cubic yards.

Of the 125.64 miles of effective levee in this district, there are on May 1, 1905, 575,613 linear feet, or 109.19 miles, built wholly or in part by the United States.

LAKE BORGNE LEVEE DISTRICT.

There is now no contract in force for levee construction, all such work having been completed.

The building of a new levee by the State authorities at each of the following places, Belair (998 L.) and St. Thomas Church (1014 L.), caused the abandonment of 7,300 linear feet of levee, embracing 54,350 cubic yards.

Of the 77.07 miles of effective levee in this district on May 1, 1905, there are 198,342 linear feet, or 37.52 miles, built wholly or in part by the United States.

Abandoned levees.—The following is a table of the previous history of each levee which has been abandoned by the construction of new levees from May 1, 1904, to May 1, 1905:

Name.	Miles below Cairo.	District.	Length.	By whom built.	When built.	By whom last enlarged.	When last enlarged.
			Feet.				
			759	State	1903		
			2,506	do	1901		
Greens	721 R.	Lower Tensas	1,873	United States.	1887	United States.	1895
			2,061	do	1887	State	1902
Fish Pond	723 R.	do	7,975	do	1887	United States.	1902
			397	do	1899		
			618	State	1897		
Eliza	843 R.	Atchafalaya	1,764	do	1880	State	1899
			1,658	United States.	1893	United States.	1895
Sardine Point	843.5 R.	do	1,135	State	1879	State	1900
Comeaux	845 R.	do	979	do	1879	do	1900
Australia	846 R.	do	1,880	do	1893	do	1899
			400	United States.	1899		

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Name.	Miles below Cairo.	District.	Length.	By whom built.	When built.	By whom last enlarged.	When last enlarged.
			Feet.				
Bayou Goula	866 R.	Atchafalaya	119	United States.	1894	State	1896
			2,324	State	1879	do	1896
Cora	870 R.	do	93	United States.	1894	do	1899
			2,190	do	1894		
Alliance	1,002 R.	Barataria	104	State	1899		
			2,955	Not known			
Point Celeste	1,010 R.	do	2,699	State	1886	United States.	1896
Point Michel	1,020 R.	do	157	do	1888	do	1896
			1,018	do	1885	State	1896
Rigaud	1,021 R.	do	1,700	Not known		do	1896
Buras Store	1,038 R.	do	96	State.	1903		
			1,819	do	1880	State	1896
Ophelia	806 L.	Pontchartrain	5,058	do	1879	do	1890
Darrow	886 L.	do	1,437	do	1879	do	1899
			257	United States.	1895	do	1899
			96	do	1894		
Raum	899 L.	do	1,154	State	1879	United States.	1895
			198	do	1890	State	1898
			240	do	1890	do	1898
Celestine	900 L.	do	1,903	do	1879	United States.	1895
			138	United States.	1891	do	1896
Belair	998 L.	Lake Borgne	3,132	Not known			
			1,468	State	1889	United States.	1897
			268	do	1903		
			680	do	1897		
St. Thomas Church.	1,014 L.	do	280	do	1884	State	1895
			1,472	do	1884	do	1897

Of the levee abandoned by the construction of a new levee at Greens (721 R.), 795 feet were built by the State authorities in 1903 and had a life of only one year; 2,506 feet were built by the State authorities in 1901 and had a life of only three years; 3,934 feet were built by the United States in 1887 and had a life of only seventeen years. Of this length 1,873 feet were enlarged by the United States in 1895 and 2,061 feet by the State authorities in 1902. The cost of either of these enlargements was less than one-twentieth of the cost of a new levee.

Of the 8,372 feet of levee abandoned by the construction of a new levee at Fish Pond (723 R.), 397 feet were built by the United States in 1899 and had a life of only five years instead of twenty; the other 7,975 feet were built by the United States seventeen years ago and enlarged by the United States in 1902. The cost of enlargement was less than one-tenth of the cost of the new levee.

Of the length of the levee abandoned by the construction of a new levee at Eliza (843 R.), 618 feet were built by the State authorities in 1897 as a wing of a levee, which wing was not expected to have a life of twenty years; 1,764 feet were built by the State authorities in 1880 and 1,658 feet were built by the United States in 1893, and had a life of only eleven years. The 1,764 feet built in 1880 were enlarged by the State authorities in 1899, and the 1,658 feet built in 1893 were enlarged by the United States in 1895. The cost of these enlargements per year of service was less than one-twentieth of the cost of the new levee.

The levee abandoned by the construction of new levees at Sardine Point (843.5 R.) and Comeaux (845 R.) was built by the State authorities more than twenty years ago and enlarged by the State authorities in 1900. The cost of the enlargement was less than four-twentieths of the cost of the new levee.

Of the 2,280 feet of levee abandoned by the construction of a new levee at Australia (846 R.), 1,880 feet were built by the State authorities in 1893 and 400 feet were built by the United States in 1899. The 1,880 feet built in 1893 were enlarged by the State authorities in 1899. The cost of enlargement was less than five-twentieths of the cost of the new levee.

Of the 2,443 feet of levee abandoned by the construction of a new levee at Bayou Goula (866 R.), 119 feet were built by the United States in 1894 as a wing, which was not expected to have a life of twenty years; 2,324 feet were built by the State authorities more than twenty years ago. These 2,443 feet were enlarged by the State authorities in 1896. The cost of the enlargement was less than eight-twentieths of the cost of the new levee.

Of the 2,283 feet of levee abandoned by the construction of a new levee at Cora (870 R.), 93 feet were built in 1894 by the United States as a wing, and 2,190 feet were built by the State authorities in 1884. The abandoned levee was enlarged by the State authorities in 1899. The cost of enlargement per year of service was less than one-twentieth of the cost of the new levee.

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Of the 3,059 feet of levee abandoned by the construction of a new levee at Alliance (1002 R.), 104 feet were built by the State authorities in 1899 as a wing to a levee, and were not expected to have a life of twenty years. The dates of the construction and enlargement of the other 2,955 feet are unknown.

The 2,699 feet of levee abandoned by the construction of a new levee at Point Celeste (1010 R.) were built by the State authorites in 1886 and enlarged by the United States in 1896.

Of the 1,170 feet of levee abandoned by the construction of a new levee at Point Michel (1020 R.), 157 feet were built by the State authorities in 1888 and enlarged by the United States in 1896; 1,013 were built in 1885 and enlarged in 1896 by the State authorities.

Nothing is known of the original construction of the levee abandoned by the construction of a new levee at Rigaud (1021 R.). The levee abandoned was enlarged by the State authorities in 1896.

Of the 1,915 feet of levee abandoned by the construction of a new levee at Buras store (1038 R.), 96 feet were built by the State authorities in 1903 as a wing of a levee, and were not expected to have a life of twenty years; 1,819 feet were built by the State authorities in 1880 and enlarged by the same in 1896.

The levee abandoned by the construction of a new levee at Ophelia (886 L.) was built by the State authorities in 1879. The bank at this levee is not caving, but the new levee was necessary on account of the scarcity of material on the river side of the levee with which to enlarge the old levee.

Of the 1,694 feet of levee abandoned by the construction of a new levee at Darrow (886 L.), 1,437 feet were built by the State authorities more than twenty years ago, 257 feet were built by the United States in 1895 as a wing of a new levee, and were not expected to have a life of twenty years. The levee abandoned was enlarged by the State authorities in 1899. The cost of the enlargement per year of service was less than one-twentieth of the cost of the new levee.

Of the 2,448 feet of levee abandoned by the construction of a new levee at Raum (899 L.), 96 feet were built as a wing to a levee by the United States in 1894; 1,154 feet were built by the State authorities more than twenty years ago, and 198 feet were built as a wing to a levee by the State authorities in 1890. The 1,154 feet built more than twenty years ago were enlarged by the United States in 1895; the 96 feet built in 1894 were enlarged by the State in 1898, and the 198 feet built in 1890 were enlarged by the United States in 1896. The cost of these enlargements per year of service was less than one-twentieth of the cost of the new levee.

Of the 2,281 feet of levee abandoned by the construction of a new levee at Celestine (900 L.), 240 feet were built by the State authorities in 1890 as a wing of a levee; 1,903 feet were built by the State authorities more than twenty years ago, and 138 feet were built by the United States in 1891 as a wing of a levee. The part built in 1890 was enlarged by the State authorities in 1898; that built in 1879 was enlarged by the United States in 1895, and that built in 1891 was enlarged by the United States in 1896. The cost of these enlargements was less than one-twentieth of the cost of the new levee.

Of the 4,600 feet of levee abandoned by the construction of a new levee at Belair (998 L.), nothing is known of the history of the construction of 3,132 feet; 1,468 feet were built by the State authorities in 1889 and enlarged by the United States in 1897.

Of the 2,700 feet of levee abandoned by the construction of a new levee at St. Thomas Church (1014 L.), 268 feet were built by the State authorities in 1903 as a wing of a levee; 1,468 feet were built by the State authorities in 1889, and 1,752 feet were built by the State authorities in 1884. Of the 1,752 feet built in 1884, 280 feet were enlarged by the State authorities in 1895 and 1,472 feet were enlarged in 1897.

Very respectfully, your obedient servant,

W. E. KNOBLOCH,
Superintendent of Levees.

Capt. J. F. McINDOE,
Corps of Engineers.

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